



# ANNALS OF SURGERY

A MONTHLY REVIEW OF SURGICAL SCIENCE AND PRACTICE

EDITED BY  
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OF NEW YORK

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## THE SEMICENTENNIAL ANNIVERSARY

OF THE FOUNDING OF THE

## NEW YORK SURGICAL SOCIETY

*Held October 30, 1929*

### INTRODUCTORY REMARKS

By the President, EDWIN BEER, M.D.

A LITTLE over fifty years ago surgery had its renaissance. To appreciate what enormous strides this comparatively new therapeutic discipline has made during these years baffles one's intelligence. Surgery of a sort had been practised for thousands of years but not until the epoch-making contributions of Pasteur and of Lister was it possible for modern surgery to commence its grand career and real life. Prior to those important discoveries there were a few limited surgical specialistic activities but surgery, as we all know it, was an impossibility and its beneficent usefulness to mankind became a possibility only after a full realization of the significance of the work of those two genial spirits.

With the opening up of this new therapeutic field, those who were specially interested in furthering its progress, in learning its heretofore hidden secrets, felt the need of a forum of their peers where honest search for truth and critical analysis might be found. This need was recognized almost simultaneously in many countries and in many cities. Surgical societies sprang up both here and abroad to meet the situation. The German Surgical Society, The American Surgical Association, The Philadelphia Academy of Surgery, and The New York Surgical Society—to mention only some of the responses to this urge—all saw the light of day in the 'seventies of the last century.

On October 30, 1879, the first meeting of The New York Surgical Society took place. To assist our minds in getting back to that date, to adjust our viewpoint to the activities of our founders (which will be spoken of by the guests of the evening), it would be well to read to you the minutes of the meeting held half a century ago:

At a meeting held October 30, 1879, at the residence of Dr. Robert F. Weir, the New York Surgical Society was organized with the following gentlemen as original members: Drs. H. B. Sands, E. L. Keyes, L. A. Stimson, Charles McBurney, T. T. Sabine, Wm. T. Bull, R. F. Weir, and J. G. Curtis.

## NEW YORK SURGICAL SOCIETY SEMICENTENNIAL

1. It was resolved that the meetings of the Society should be semi-monthly and be held during the months of October, November, December, January, February, March, April and May.

2. That the meetings should begin at eight o'clock and that business should be transacted in the following order:

1. Presentation of patients and discussion of the same.
2. The subject of the evening.
3. Narration of cases with comments.
4. Presentation of pathological specimens.
5. Reports of committees.
6. Miscellaneous business.

3. That the meetings should be held at the houses of members in alphabetical order and that no supper should be allowed.

4. That no member shall be allowed more than ten minutes of the Society's time except in the stated discussion.

5. The officers of the Society shall be three in number, namely, President, Vice-president, and Secretary and Treasurer.

6. That two negative votes shall reject a candidate for membership.

An election of officers was then held and Doctor Sands was made President, Doctor Weir Vice-president, and Doctor McBurney Secretary pro tem. The following gentlemen were elected members of the Society—Drs. Van Buren, Markoe, Peters, Mason, Little, Lange, and Guleke.

The Society then adjourned to meet November 4 for complete organization.

R.F.W.

Following the October 30 meeting, the organization was perfected at the November 4 meeting and the first scientific session took place November 25 at the house of Dr. William T. Bull, at which thirteen members were present. Doctor Van Buren read a paper on "Submental and Subhyoid Cysts" which was discussed by Doctors Peters, McBurney, Markoe, Little and Sands. Doctor Peters presented a case of litholapaxy followed by profuse periurethral suppuration. This was discussed by Doctors Van Buren, Sands and Keyes. Doctor Stimson then showed the results of a series of experiments undertaken to determine whether or not the carbolic spray actually purified the air, as Lister claimed.

These few words present the background of the Society's birth. The first speaker at this meeting to celebrate the semicentennial year of the Society's existence will be Dr. Fred Lund, of Boston, President of the American Surgical Association, not only a surgeon of renown but a student of surgical history, who will address us on the subject of "The Influence of the New York Surgical Society on the Development of Surgery."

# THE INFLUENCE OF THE NEW YORK SURGICAL SOCIETY ON THE DEVELOPMENT OF SURGERY

BY FRED BATES LUND, M.D.  
OF BOSTON, MASS.

IN THE genealogy of the Greek gods, you will find the beautiful myth that memory, or *Mnemosyne*, was the mother of the muses. I cannot do better than to begin our proceedings with a prayer to her.

*Oh! Mnemosyne, mother of the muses, who gives to man his greatest gifts from heaven, the power of song and story and the things of the spirit and the mind, I pray thee look with favor upon thy suppliant, who attempts to tell the story in thirty minutes of fifty years of the active, seething life of this Society. Turn kindly toward him the spirits of the illustrious dead and the hearts of his living auditors; if he, as he will, leaves unsaid the things that he ought to have said and says the things that he ought not to have said, and his words prove inadequate, may they accept in their place his right good will. Amen.*

The New York Surgical Society did not, like the Goddess Athena, spring full-armed from the head of Zeus, with sword, shield and ægis complete, but none the less it had its origin in the brain of a great man. The brain was that of Dr. Lewis A. Stimson, who wrote the textbook on fractures, which lasted well into my time, who was a constant contributor to the proceedings of your Society, who was always on the edge of progress looking over the horizon ahead, and who was for many years one of the leading surgeons in New York City. Not the least of his accomplishments was that he was the father of my friend, the Honorable Henry L. Stimson, the Secretary of State of these United States. He had a personal acquaintance with the Société de Chirurgie of Paris and was a constant reader of its bulletins. His suggestion for a surgical society for New York was laid before Van Buren and a few others, who adopted it, and on October 30, 1879, at the house of Dr. Robert F. Weir effected a preliminary organization. These men, like the hand that built St. Peter's dome, builded better than they knew, and the small building, of which they laid the corner stone, has become the mighty edifice of the New York Surgical Society. Those taking part in the first meeting were Doctors Sands, Keyes, McBurney, Stimson, Sabine, Bull, Weir, and J. G. Curtis. Doctor Sands was chosen president and Doctor McBurney secretary.

I always feel a certain pity for the younger men of our profession, for the reason that they cannot have really known the older men whom we ourselves looked up to with such reverence and affection—such men as Doctors Cheever, Homans, C. B. Porter, and Maurice Richardson, in Boston, and in New York the eminent founders of this Society. They can only know them

through our inadequate efforts at the portrayal of their character. A young man's enthusiasm for his teacher is one of the finest things in our profession, and has been so since the time of Hippocrates. These men, the founders of this Society, were the heroes who taught and moulded, and gave character to the profession of Surgery in New York, the greatest city of our country, offering to its members a clinical and hospital experience surpassing that of any other. This Society was a society of surgeons, which meant that whoever read a paper or reported a case was submitting it to a jury of his peers. Think of the advantages to the young surgeon of membership in such a society, a place where professional jealousies are forgotten, where each man is sure of keen criticism, and all are animated by the love of truth and the desire to help their patients. Only surgeons can truly understand or criticize surgical work. That is the reason that surgical societies and surgical sections are the places to present surgical cases. One is also in such meetings free from the imputation of attempting to please the medical public in order to increase his personal gain. Medical men, whose superior wisdom and attainments I would be the last to deny, can never understand our art, which as Aristotle stated, and Henri de Mondeville emphasized, can only be learned by its practice. "If the mind must guide the hand in an operation, the hand instructs the mind in the knowledge of what it can do," said the eminent surgeon of mediæval days. Besides, in a society made up of rival practitioners of surgery, one is always sure of criticism of any defects in his work, which is after all better for one than indiscriminate praise. We must never forget the stimulation to study and effort that the reporting of cases in such a society has upon its members. There is no way so sure to clarify our own knowledge as to present our work for criticism to our peers. I think it was Dr. Charles Mayo who truly said, "the man who gets the most benefit from a paper is the writer of it," and also, "the man who hasn't time to write papers will find in a few years that he has more time on his hands than he wants." To my mind there is no satisfaction greater in one's life than to present something really worth while in a surgical meeting, though I am compelled to admit that in my own life such thrills have been relatively rare.

At the time the New York Surgical Society was founded, as Doctor Stimson stated in 1913, "The differentiation of practice had indeed begun, but, except for certain specialties, such as the eye and ear, it had barely advanced beyond the manifestation of a preference on the part of some general practitioners for certain lines of practice. Even Sands, who was just entering upon the brilliant last ten years of his life, still kept some families, and only two or three, and they young men, had declared an exclusive attention to surgery. Sabine had done so for a few years; Lange had just come to us from Germany. Antiseptic surgery, too, was just establishing itself among us, and it was only three years since the first Lister spray had been brought here and the first operation according to his method had been performed in one of our hospitals. The field of surgery was just beginning to enlarge under its influence, to enter upon that astounding expansion which the last

thirty years have witnessed. The signs of that expansion were already visible, men's thoughts were occupied with the possibilities of future surgery, the need of specialization in it was evident, and, in short, the time was ripe for a society devoted to its consideration."

Since these prophetic words, the expansion has gone on at a rate no less than it had taken on at that time. The substitution of asepsis for antiseptis, X-ray, radium and all the wonders of radiation, the specialties of genito-urinary surgery, orthopædics, the surgery of the nervous system, the enormous refinement of the surgery of the abdomen, transfusion, the surgery of the spleen, and thoracic surgery, in which much good work has been done in New York, are only a few of the fields in which Surgery has spread its beneficent influence, so that it may be truly said that in the last eighty years our art has progressed further than in the three thousand years preceeding.

One of the most valuable things the New York Surgical Society has done is to constantly provide for the publication of its transactions. Dr. Wesley Carpenter reported the earlier discussions which were first published in the *New York Medical Record*, but ever since 1892 have been published in the *ANNALS OF SURGERY*. All through my own professional life I have enjoyed reading the remarkable cases published in these Transactions and have sometimes been encouraged to go and attempt to do likewise. Such has been the effect of the penetration of the transactions of the New York Surgical Society to a remote and inaccessible part of New England. For the preparation of this address, I have been entrusted with the reports of the Society in manuscript, written by the hands of the secretaries from 1879 to 1919. I have read them reverently and carefully. They, with the transactions published in the *ANNALS OF SURGERY* since that date, form an epitome of surgical progress in this country. There are two years in the handwriting of the great Doctor McBurney, eight years in that of that charming gentleman and sportsman, Dr. LeRoy Milton Yale, followed by Dr. Frank Hartley, that brilliant genius in our art, then Drs. Andrew McCosh, Frank W. Murray, Lucius W. Hotchkiss, etc., etc. Occasionally there is a certain element of amusement in the proceedings. At one of the earlier meetings Doctor Bull read a paper on hernia. At the meeting before he read the paper he made a motion that a young surgeon, Dr. W. B. Coley, who had assisted him in its preparation, be invited to be present and discuss the paper. The motion was lost.

I realize that in attempting to cite some of the more important papers and discussions, which to me seem to have contributed to progress in surgery, I shall commit many sins of omission. I shall attempt of course only to touch the high spots and shall miss many of them, but I hope Mnemosyne will remember my prayer. I shall omit most of the interesting business meetings, where the dues were raised from one dollar to five and then to ten dollars, and then reduced to five again, the gradual enlargement of the membership from twenty to twenty-five and so on to the present number as the city expanded and the work with it, and the troubled question of publication, which finally came to a most satisfactory settlement with the *ANNALS OF SURGERY* and



Dr. Lewis Pilcher, who is here with us tonight. I was filled with pride by the account of the meeting held November 9, 1892, in which a motion was made that the five leading journals of the country be invited to send reporters to the meetings and that notices of the meetings be sent to such journals. On looking at the list I saw that "Lo, Ben Adhem's name led all the rest" for the first on the list was the *Boston Medical and Surgical Journal*, upon which I was soon to enjoy the position of Assistant Editor. The remainder of the list consisted of the *Medical News* of Philadelphia, the *Journal of the American Medical Association*, the *New York Medical Record*, and the *New York Medical Journal*.

At a meeting in the late eighties Doctor Wyeth moved that "a transcript of the proceedings of the Society be sent to every medical journal in the country." The motion was lost.

I know who attended the meetings and who did not, who had to be disciplined and who did not, but, as far as I am concerned, the facts shall remain a profound secret. I am not a modern muckraking historian. There were all sorts of salutary regulations about losing one's membership if one did not read a paper once in so often, and attend a certain percentage of meetings, which must have tended to keep the members up to their work and have helped toward the remarkable success of the Society.

After several years of meeting in the Governors' Room of the New York Hospital, the Society began to meet in the old Academy of Medicine and now I presume enjoys the luxurious surroundings in which we are meeting at present.

I think perhaps the most interesting way to take up the contributions of some of the members to the surgery of the period will be to speak of them in connection with the subjects of discussion at what seem to be the more important meetings.

This Society was begun just at the time that operations for appendicitis were beginning to be done. Although Boston can claim to be the birthplace, so to speak, of appendicitis, it was Charles McBurney, of New York, a founder of this Society, who gave special attention to the refinement of diagnosis and operative technic. McBurney's point and the McBurney incision became bywords. In regard to appendicitis there were noteworthy meetings. At the fifteenth meeting, in 1880, Doctor Sands read a paper on perityphlitis. On March 3, 1888, Doctor McBurney reported a case of perforation of the vermiform appendix in which two calculi (sic) were found in the appendix. On October 23, 1889, Doctor McBurney's paper was entitled, "Experiences in the Early Operation for Abscesses of the Vermiform Appendix." Doctor McBurney's work on the appendix was not the only contribution he made to surgery. In 1891 he removed a gall-stone through the duodenum, he suggested the compression of the femoral artery through an abdominal incision in amputations, his were the brains and interest that built the Syms operating theatre at the Roosevelt Hospital and, in connection with the manufacturers, developed the modern pressure sterilizer.

Doctor Bull bore the same relation to hernia that Doctor McBurney did to appendicitis. The relations of the Society to the development of the subject are illustrated by a paper by Doctor McBurney, a case of radical cure of hernia in March, 1888.

In 1882, the Society had a discussion on Heaton's method for the radical cure of hernia. I wonder how many students of our day remember what that was. Suffice it to say that Bull and Weir reported forty-one cases with fourteen recoveries. This blind procedure, as well as McBurney's open method, McEwen's folding of the sac, etc., have all gone into the scrap heap, but they were all steps in the progress which has brought us up to the present, and will continue into the future. Notable papers by Doctor Bull were: March 25, 1891, "Notes on cases of hernia relapsing after various operations for radical cure" and "Notes on the mechanical and operative treatment of hernia" in 1893.

Doctor Stimson's contributions to the early meetings included, in 1880, "A case of ligature of the carotid and subclavian for innominate aneurysm." Of course, he was a constant contributor on fractures, and reported many operations on fracture of the patella, which in the early days caused so much discussion. How long ago that seems. Doctor Stimson was also one of the first to ligate the ovarian and uterine arteries in removal of the uterus, in January, 1889. I remember well a visit of his to the Massachusetts General Hospital in Boston about 1892, when he spoke on the ligature of the arteries in hysterectomies, which soon displaced the antiquated and barbarous procedure of the wire around the stump which was left outside to slough, another of the unhappy memories, with which we are glad our younger brethren are unacquainted. Doctor Stimson illustrated all sorts of subjects and was a really great writer on surgical themes. In 1889, he made the following shrewd observation on a case of fracture of the clavicle, with dislocation of the costo-chondral joints of several ribs. "In these cases he had noticed a change of color over the chest and face, and in some cases with hæmorrhages into the cavities of the body and about the eye. The discoloration he thinks is not due to the extravasation of blood. The patients are so dark that they may be mistaken for negroes. This is due to the blood coloring matter, but how is not known,"—a good description, of course, of what we call traumatic asphyxia in our textbooks.

Doctor Weir's early labors in perforation of the stomach, we all remember. Doctor Weir was an intense worker in the field for many years and many were the contributions made by him to surgical knowledge. The first meeting of the Society was held at his house and as early as the fourth meeting, namely, December 9, 1879, he reported a case of "Cystic degeneration of the appendix vermiformis." I well remember his presiding over the surgical section of the American Medical Association in Boston in 1902, and his impressive presence, piercing eye and noteworthy comments on the papers.

In 1892, Doctor Lange, filled with scientific enthusiasm, moved that the Society purchase a microscope. A committee of one was appointed to see if the Academy could furnish one to the Society.

As early as 1889 Doctor Abbe was writing on vegetable plates in intestinal obstruction. In 1884, at the seventieth meeting, Doctor Halsted reported the removal of a human tooth from a man's hand with the statement that "the evidence was agin him."

In November, 1892, Doctor Coley spoke on Bassini's operation for hernia. Ever since then, here and there through the transactions, may be found his contributions to this subject. In connection with Doctor Coley, the following note is of interest, "March 25, 1896, report of a committee consisting of Doctors Stimson, Gerster and Curtis, on the treatment of malignant disease by erysipelas toxins." The method was strongly condemned. That the effect of this condemnation was not permanent may be seen from the contributions by Doctor Coley on the subject which are scattered through the reports of the Society ever since. In fact, it may be said that Doctor Coley's contributions to the treatment of bone sarcoma have been a very important part of the work of the Society.

One cannot forbear to mention the valiant work of Dr. Willy Meyer on the surgery of the chest, and his construction and use of the Sauerbruch Cabinet. Although the cabinet has been replaced by the intratracheal method of Meltzer, also a product of New York, its construction and use required a lot of labor and enthusiasm, and was a step in the right direction. Doctor Meyer was also a pioneer in the modern operation for cancer of the breast and many other subjects.

On May 11, 1910, Doctor Lilienthal reported the first human thoracotomy under intratracheal anæsthesia. The remarkable achievements of Torek and Lilienthal in the successful removal of cancers of the œsophagus were directly due to this wonderful device of Meltzer.

As early as March 23, 1888, Doctor Lange reported a gastro-enterostomy for carcinoma of the stomach, which is the first report of this operation that I can find in the records. Later, Doctor Brewer, in collaboration with Doctor Cole, röntgenologist, contributed to our knowledge of gastric surgery. His work, too, marked a step in the progress of our knowledge of infections of the kidney, and for many years he was a constant and enthusiastic contributor to the Society's proceedings.

On December 14, 1904, it was moved that the Society celebrate its twenty-fifth anniversary by giving a dinner, to which the original members be invited as guests of the Society. The dinner was held, as may be inferred from the note that at the meeting on February 8, 1905, the treasurer's report on the anniversary dinner was read and approved. But alas, the dinner was not reported in the secretary's minutes. Perhaps some of the members here tonight can tell us about it, for since then all the original members who might have been present then have gone to their reward.

On November 11, 1908, Doctor Erdmann was writing on "Acute Hemorrhagic Pancreatitis."

In 1910, Doctor Woolsey on "Transfusion for Pernicious Anemia." Of the many contributions of Doctor Woolsey to the Society, over a long period, I have not time to speak, except to mention an early case of suture of gunshot wound of the intestine.

In regard to the surgery of the thyroid, the first mention of it I found in the Society's proceedings was on May 22, 1889, when Frank Hartley spoke on the "Operative treatment of Struma." "Doctor Lange had seen a case of secondary hæmorrhage following the operation." Doctor Lange was not the only one who in those early days had seen this.

On November 23, 1892, Dr. B. F. Curtis reported the successful removal of a tumor of the brain.

In 1910 Doctor Woolsey presented the subject of "Transfusion for Pernicious Anemia."

In the scanty notes that have preceded, nothing has been said about the development of prostatic and genito-urinary surgery, although Doctor Keyes was one of the original members of the Society. We all remember J. William White's orchidectomy, etc. In 1892 one of the prominent members of the Society reported a ligation of both iliac arteries for hypertrophy of the prostate followed by ligation of the left common iliac for secondary hæmorrhage from the external wound, caused by pressure of forceps on the internal iliac. The prostatic hypertrophy had certainly disappeared six months after the operation. The present safety of prostatectomy certainly contrasts with the dangers which in the early days made the attempt of difficult and indirect methods justifiable.

In January, 1911, Doctor Gerster reported on splenectomy for Banti's disease.

On October 25, 1911, Doctor Kammerer reported a complete removal of the larynx, thyroid gland and six inches of the œsophagus for cancer; no recurrence after six months.

About this time meetings were beginning to be held at the various hospitals. At some of those meetings the programs were really tremendous. Often twenty or thirty cases would be presented and discussed, in addition to the paper of the evening.

On April 19, 1913, the membership, which had been during the years gradually increased, was brought up to sixty.

On November 25, 1914, Torek presented his wonderful case of resection of the œsophagus for carcinoma; well twenty and one-half months after operation.

In 1913, Weir again presented the subject of perforations of the stomach and Moschcowitz made his contribution to the subject of sliding hernia. At this time Alfred S. Taylor had something to say about Erb's paralysis. Syme spoke of lymphangioplasty by Handley's method. Joseph Blake read a paper

on splenectomy for Banti's disease. The subject of Doctor Blake's contribution brings up the subject of the part taken by the members of the New York Surgical Society during the war and the important place which Doctor Blake's sanity, brilliance and enterprise gave him in the treatment of fractures, simple and compound, in the military service. Of the units headed by Brewer, Peck, John Walker and others, and the services of Pool and many other distinguished men of this Society as consulting surgeons, the New York Surgical Association certainly may be proud.

I have said nothing about the remarkable work of Burton J. Lee, at the Memorial Hospital, on cancer and the treatment by radiation. I have not entirely forgotten Carrel—who could?—and the absolutely incalculable lives he saved by his introduction of the Carrel-Dakin treatment during the war, or his no less miraculous work in the suture of arteries, making possible the transplantation of viscera, and the cultivation of living tissue in vitro.

Elsberg's work on tumors of the spinal cord must not be forgotten nor the contributions of Lyle to the difficult field of the surgery of the hand in industrial accidents.

In 1919 Chas. H. Peck was president of the Society and on October 9, 1918, read a paper on "Hospitals of the American Expeditionary Forces."

In 1920 Burton James Lee spoke on the "War's Contribution to General Surgery."

To one who has constantly read the proceedings of the New York Surgical Society and the Philadelphia Academy of Surgery, it was an event of great interest when the two societies in recent years began to combine their meetings. Think what a galaxy of talent that produced! The combined meetings have constantly been successful and the combination of two points of view has perhaps often brought us nearer the truth.

If I might characterize the prevailing temperament of the New York surgeons I have had the privilege of knowing, I would say that they were characterized by indomitable enthusiasm and energy, and sincere love for their profession, qualities which it is easy to see are most favorable to progress.

Nothing has yet been said about the influence of the members of the New York Surgical Society in the work of the American Surgical Association and the other great surgical and medical associations. The sharp debates, the acute criticism and the surgical enthusiasm which has been fostered by this Society, has enabled them to take a leading part in the proceedings of the Surgical Association, and numbers of its members, many of them who have been mentioned in this address, and many of whom are here in person, have served as presidents, secretaries and other officers of the national association.

In the eleven years since the war, the work of the Society has gone on with undiminished activity. Doctor Lilienthal has made many contributions to thoracic surgery; Dowd, Matthews, Pool, Walton, Martin, Downes, St.

John, and others, have taken with undiminished brilliancy and success the places of those who preceded them in the active work of the Society. Gibson has done valiant work as introducer and sponsor of the follow-up system, and has made many other valuable contributions to our art. Whipple has contributed on omentopexy and splenectomy in cirrhosis of the liver, on cancer and pancreatitis and upon many other subjects.

You will notice that there is one man whom I have not mentioned, a former president, Dr. Ellsworth Eliot, whom I craftily left until the last, because I wanted to leave a good impression on his mind, since he is the only one who has an opportunity to reply to what I say. Suffice it to say that he has been for many years a frequent and valued contributor to your meetings as well as to those of the American Surgical Association, of which he was president last year. The subjects on which I remember him best have been intestinal obstruction and the surgery of the gall-bladder. His work has been characterized by intelligence and judgment. He is a friend of long standing and has gone out of his way to be kind to me in the past. I fear the less his reply.

Among the earlier members of the New York Surgical Society was Arpad G. Gerster, first surgeon in chief of the Mt. Sinai Hospital when it was new, also surgeon at the German and other hospitals. He was a president of this Society, and of the American Surgical Association. An immigrant to this country, he came here with qualities of heart and head which few of us possess. He was a thorough classical scholar. He loved learning, he loved nature, and he loved God. He was an ardent hunter and, especially, fisherman. I used to meet him on some of his fishing expeditions with the late Dr. LeRoy M. Yale, your second secretary. He loved many forms of sport, rode a horse, rowed a boat, and explored Long Island Sound in his canoe. He wrote the book on "Aseptic Surgery" which was our guide in practice during many years. He exemplified the saying of the great Hippocrates that where there is the love of man, there is the love of the art of medicine. "None knew him but to love him, none named him but to praise."

On looking through the precious records of the Society I found in the back of one of the volumes a little sketch, marked in the lower right-hand corner, "A. G." and in the lower left-hand corner, "Surgical Society, March 22, 1893." Doctor Gerster presided at that meeting. It was evidently made on a scrap of scratch paper either to keep him awake, or enable him better to endure the tedium of the paper of the evening, which was on the subject of cholecystitis, and by a very eminent surgeon of that day. But it illustrates the things he had in his mind and heart that helped him through the long grind and hard work of his practice. He did love his play. He was skilled with his pen and brush. Whether it is a portrait of his camp on Lake Raquette (where he had one) or not, I do not know. But it reminds one of the fact that even at meetings of the New York Surgical Society, the mind of its president might be elsewhere attending to what was for a lover of nature

and of beauty the real business of his life. Said Schiller: "To speak out once for all, man only plays when in the full meaning of the word he is a man, and he is only completely a man when he plays. Schiller: Essays Aesthetical and Philosophical. And if the ghost of Lord Byron will forgive me, I will paraphrase a few famous lines of his about a gladiator:

He heard it but he heeded not—his eyes  
Were with his heart and that was far away.  
He recked not of the learning lost nor prize,  
But where his rude hut by the Raquette lay,  
There where the trout and salmon leap and play,  
There where the sunset's glowing robe of fire  
Tinges the dark blue wavelets of the bay.

Among the many omissions in this address have been references to the invaluable services of the members of the Society in the teaching of surgery. Suffice it to say that the majority of them have been, and are, professors in the great medical schools of New York, and many have devoted a large part of their lives to the teaching of their art to students of their profession. There is no finer way to pay our debt to those who taught us the art, than to pass on their teaching, enlarged and modified by our own experience, to those who are to follow in our steps. This in overwhelming measure the members of this Society have done. And now the time has come to bring to an end my discourse, again commending it to you with reference to my opening petition. To the future, this Society may look with hope and confidence. Suffice it to say that if the same enthusiasm, sound sense and energy shall continue to animate the Society that have characterized it in the past, the future will not be unworthy of that which has gone before and we may well say to the Society, now fifty years young, and proud of the accomplishment of every year, in the words of the great Latin poet whose two thousandth anniversary will be celebrated within a few months of its fiftieth milestone, "*Macte nova virtute, puer, sic itur ad astra.*"

Remarks of PRESIDENT BEER, introducing DR. WILLIAM J. MAYO:

There are few clinics in the world that are more hospitable to new ideas and to visitors than the Mayo Clinic at Rochester. Dr. William J. Mayo made it a practice to visit New York City for long periods over many years when he was a young man and thus had the opportunity to come into contact with many of our original membership. I love to think his reception by our founders may have contributed to the development of the hospitable atmosphere of the Mayo Clinic. In view of his intimate relations with so many of our earlier members, I know of no one better fitted than he is to dwell on the more personal side of New York City's eminent surgeons during the first thirty years of our activities. It is a privilege and a great pleasure to introduce to you Dr. William J. Mayo, who will address us on his "Personal Reminiscences of the Members of the New York Surgical Society."

# EARLY DAYS OF THE NEW YORK SURGICAL SOCIETY

BY WILLIAM J. MAYO, M.D.

OF ROCHESTER, MINNESOTA

THE New York Surgical Society was organized fifty years ago by a group of surgeons in New York who were actuated by the desire not only to advance the science and art of surgery, but to develop character in its members, and by example as well as precept to encourage right thinking in the many surgeons of foreign extraction who perhaps had accepted a viewpoint of professional ethics which was not like-minded with American ideals.

New York was and is the great metropolis of America, the entry port for that enormous immigration from foreign countries which, in the later decades of the nineteenth century admitted to our shores, with the great masses of desirables, many undesirable immigrants. One notes that when the American Surgical Association was organized in 1880, among its charter members were many of the men who had organized the New York Surgical Society the year before, the ideals of whom were embodied in the American Surgical Association.

The conditions of medical practice in the United States in the early days were interesting. In the "History of Medicine," by Colonel Garrison, one will find valuable historical data. Dr. J. M. T. Finney, in his Hunterian Lecture (January 17, 1927); has traced the influence of John Hunter on American surgery and has given an enlightening perspective of surgery in the United States in colonial times.

The three cities in which scientific medicine had its chief habitation in the early days were Philadelphia, Boston and New York.

In Philadelphia was the Philadelphia Hospital, the first hospital established in the United States. The College of Physicians of Philadelphia, the University of Pennsylvania, and the Jefferson Medical College, working together with a degree of unanimity which was most praiseworthy, enabled Philadelphia to play a great part in the development of scientific medicine in our country. I will not at this time do more than mention the Grosses, father and son, the Pancoasts, Agnew, Ashhurst, and other men of the nineteenth-century construction period, men who established ideals and standards which are still maintained in Philadelphia.

In Boston, the faculty of the Harvard Medical School and the men connected with the Massachusetts General Hospital and the City Hospital exercised an influence equal to that of the Philadelphia groups in maintaining the highest standards of the medical profession. The influence of the distinguished New England group, the Warrens, the Cabots, Bigelow, Nathan Smith, Charles B. Porter, John Homans, and Maurice H. Richardson may



be mentioned. Philadelphia and Boston were developing an American surgery largely on the British concept.

New York was cosmopolitan. Its population was already showing signs of cleavage into groups influenced by their origin and ingrained habits of mind and training. The increasing differences in thought and practice made the organization of the New York Surgical Society in 1879 necessary for proper development of sound surgery. We must also take into consideration the great advances in medical science which were brought about by the discoveries of Pasteur, and their application by Lister in the latter half of the nineteenth century, which was destined to remake American surgery.

It is interesting to visualize the three great European schools of surgical thought that so greatly influenced American practice.

The Latins, as exemplified by the French, because of the rapidity and accuracy of their mental processes, are leaders of intellectual life. No people in the world with whom I am acquainted have the same power of almost instantaneously marshalling their knowledge and converting it intuitively into wise action. Pasteur's work was of more value to the human race than that of any other man who ever lived. The names of those who did great work in the field of modern French surgery are too well known to make mention necessary; yet one must speak of Péan, Tuffier, Hartmann, and Championnière. Langenbeck studied in France, and carried home with him the foundation of Germanic surgery.

The peoples of the Teutonic nations have a gift for gathering accurate information, encyclopædic in its nature. If one wants to know all about a subject, he will find that the Germans have all the data, staggering and sometimes even confusing in the wealth of detail. From this nation came Virchow. The Teutons early accepted the teachings of Lister, and in fact Semmelweiss, a Hungarian, was the first exponent of Listerian methods in continental Europe.

The new régime produced in Germany men of the most extraordinary distinction, Langenbeck, Volkman, Schede, Trendelenberg and von Eschmarch, to name only a few, and in German Switzerland, Kocher.

In Austria were Billroth, and that famous school of surgeons who followed him, of whom von Eiselsberg and Mikulicz are outstanding.

British medicine by tradition and language is closely related to American medicine. England, sound, solid, and conservative, is the home of clinical investigation. Always is the patient the compass which guides medical science, and clinical investigation thus guided brought Lister to undying fame.

In Scotland the scientific study of anatomy and physiology is at its best. I have never seen more beautiful dissections than those made by Scottish surgeons, the gift of their careful anatomical training.

Wales gave us Robert Jones, with whom began modern orthopædic surgery, in its best sense.

Ireland has taken an extraordinary part in medical advancement. The

Rotunda Hospital, in Dublin, for example, to which our knowledge of obstetrics owes so much, demonstrates the conspicuous position of Ireland in medicine.

Scientific contributions from England, Scotland, Wales and Ireland go to make up British surgery. Add to these diverse gifts those from Canada, Australia, New Zealand, and South Africa, and one gets an idea of the richness of medical science and art of Britain as a whole.

The men on the staffs of the hospitals of Great Britain have always been distinguished for their contributions to medical science. The thought of Guy's Hospital, London, for example, brings many honored names to mind. It was here that Belchier introduced the injection of madder dye into the vascular channels in the cadaver, a procedure which enabled the Hunters to do their great work on the lymphatic channels, second only to that of William Harvey in the discovery of the circulation of the blood.

Richard Bright, working at Guy's, in 1828, accurately described acute nephritis in its relation to albuminuria, clinical investigations carried out with the aid of a tablespoon, nitric acid, and a candle, and from necropsy examinations, and in 1838 described the granular contracted kidney of chronic nephritis. Addison in 1849, in a few short pages, gave that graphic description of pernicious anæmia which has stood the test of time, and, in 1855, described the syndrome related to the suprarenal glands which carries his name. Hodgkin here accomplished his work on lymphadenoma, the exact nature of which is still in dispute. Hilton, while at Guy's, wrote his extraordinary work on rest and pain, which my father said was the most illuminating book of its kind he ever read. Hilton Fagge wrote the only "Practice of Medicine" that I have ever studied which compared with that of Osler. One can turn to its pages and find quickly clinical investigation corrected by necropsy data.

I have always considered Jacobson's "Operations of Surgery" the greatest work on operative surgery which I ever studied. Sound and sane, it covered the salient features of anatomy and physiology, and with wise caution indicated the peculiar procedures which would be best suited to meet individual conditions. I owe Jacobson much.

Changing conditions in medical education brought into New York not only men who had been educated abroad, but also many Americans who had spent one or two or more years in European countries, and had brought home with them knowledge which they had gained by their training abroad.

The new surgery was established perhaps more quickly in New York than in any other place in the States. Arpad Gerster (1873), and Fred Lange (1879), both of New York, and both members of the New York Surgical Society, and Christian Fenger of Chicago (1877), all educated in Europe, were the leading exponents of aseptic and antiseptic surgery in the United States.

I was graduated from medical school in 1883, when I was twenty-one years of age, and I first went to New York City in the autumn of 1884.

Thereafter, each year for several years, I spent six or seven weeks in New York, as did my brother, Charles. My first course was at the New York Post-Graduate School in 1884; the next in the New York Polyclinic, in 1885.

Of the many fine teachers in the New York Post-Graduate School in 1884 with whom I came in contact, I remember best Dr. James L. Little, a member of the New York Surgical Society. Doctor Little was a large, handsome man, with a white beard, and hair somewhat scanty on top. He always looked well groomed. At that day tobacco was chewed more than at present, and I have seen some worthy practitioners of years ago whose beards bore evidence of the fact. Professor Little was immaculately clean. His hair and beard fairly shone, and his face was pink rather than congested, as were the faces of so many men in those days from the use of alcoholic beverages.

Antiseptic surgery was attracting the attention of a few American surgeons, but generally speaking, the surgery at that time was the surgery of necessity. Operations of expediency were done but rarely. Professor Little was just beginning to be influenced by the teachings of Lister. His results were excellent, because, as was said of Lawson Tait, he was so clean naturally.

But the surgeon of that time who impressed me most was Dr. Henry B. Sands. Doctor Sands was a small man, with a gray moustache, and scanty hair on the crown of a splendid head. He wore glasses, and when talking often unconsciously removed and polished them. He was the first president of the New York Surgical Society. Sands started in medicine as an ophthalmologist and changed over to general surgery. He became the chief surgeon at the Roosevelt Hospital, where there was gathered around him a brilliant group of younger surgeons, most of whom now, unfortunately, have passed on: Charles McBurney, Frank Hartley, Robert Abbe, and William T. Bull, all members of the New York Surgical Society. In witnessing Sands' work, therefore, I early became acquainted with these coming master surgeons, whose great careers were just before them. I have always had a most kindly feeling for Sands as a man, as well as great admiration for him as a surgeon.

The small amphitheatre of the old operating room at the Roosevelt Hospital was circular, and suspended, so that one went by a little passage into an outlook from which one had a view almost directly down on the operating table. The clinics at the Roosevelt Hospital began at two o'clock in the afternoon, and I was always there at one o'clock in order to secure a favorable seat. The clinics were often prolonged, and sometimes it was half-past six or seven o'clock or later before they were completed, but there I sat. At the close of a long day an orderly had brought Doctor Sands a message, and as he received it, he looked up and saw me still sitting in the amphitheatre. He said to me in his friendly way, "I see you sitting here through every clinic. You can go away, but I must stay until my work is over. They tell me that there is an interesting case out in the surgical ward. Perhaps you would like to go with me." I certainly would like to go with him, and I went.

In the ward was a man with a swelling in the right iliac region, very ill,

with fever and vomiting. After asking me to examine the patient, Doctor Sands said, "I believe we have here a perityphlitic abscess described by my old teacher, Willard Parker. These abscesses rupture sometimes and cause fatal general peritonitis. I do not know why this region should be so susceptible to these foul abscesses. We will give the patient a little chloroform and open the abscess here in the ward." He opened the abscess and put in a drain and then said, "I never like to squeeze an abscess to get the pus out because it may injure the protective wall about the collection of pus. If there is free drainage the pus will run out fast enough. I have noticed that if one is in too much of a hurry to empty an abscess one will often get a little blood and the patient will not make so tidy a recovery. Washing an abscess out seems to delay healing; perhaps thinning the pus makes absorption easier. Nature seems to take better care of such abscesses, if the drainage is good, than we can by anything we can do."

Doctor Sands asked me whether I had ever seen cases of this kind, and I said that I had. I had seen my father operate in several cases in which there were foul abscesses of a similar nature. I told him that one little trick my father had was to use a large hypodermic syringe with a large needle which he introduced to locate pus. He never removed the needle, which he used as a guide, until he cut down on the abscess, because, he said, he formerly had introduced a syringe without retaining the guiding needle, for various types of abscess empyema, abscess of the liver, and comparable conditions, and had not always been able to find his way into the abscess again. When I told him this, Sands laughed. "I have often been in exactly the same fix. It is a good idea." It is still a good idea.

In 1885 when I returned to New York for study, John A. Wyeth, a member of the New York Surgical Society, was at the head of the New York Polyclinic. He was a southerner and had served in the Civil War with the great cavalry leader of the South, Forrest, for whom he had ardent admiration. He was an excellent surgical anatomist and did noteworthy work on the surgery of blood vessels. An easy, fluent speaker, and a man of attractive personality, he nevertheless was not popular with the New York surgical profession; whether this was a result of the feeling aroused by the war, I do not know. He was President of the American Medical Association in 1902.

At the New York Polyclinic I came in contact with the man who I believe did more for American surgery as a whole than any other man of his time. Without discussing here his great experience and skill as a surgeon, Arpad G. Gerster, a member of the New York Surgical Society, brought to America aseptic and antiseptic surgery, which he carried out at the Mt. Sinai Hospital. I have always been rather pleased that in one of the photographs taken by Gerster which went to make up that splendidly illustrated volume, "Aseptic and Antiseptic Surgery," I appear among the bystanders. This book of Gerster's went through three large editions, but he never revised it. When I came in after years to know him well, and asked him about it, he said, "I

wrote all I had to say at that time." Gerster was a Hungarian, although of Swiss descent, and he had been trained in the Teutonic school of surgery.

At the same period Frederick Lange, a member and founder of the New York Surgical Society, was working at the German Hospital and teaching, as Gerster did, the principles of aseptic and antiseptic surgery. Lange did not write much. Because he did not speak distinctly, he was only a fair teacher, but no one could attend his clinics without the greatest benefit. He retired to Germany before the Great War.

Christian Fenger, of Chicago, was a Dane. Like Sands, he was trained as an otologist and ophthalmologist, and would have been made head of the department at the University of Copenhagen if it had not been for his defective speech. He went to Egypt and from there to the United States. In Chicago he did for modern surgery what Gerster did for it in New York.

My brother and I soon established an acquaintance with the New York hospitals and New York surgeons which enabled us to choose the men who could give us the most. The intention was to travel each year for a certain length of time, first at home and then abroad, to study a particular subject under the masters of that subject, and then to take courses in surgical anatomy or physiology or whatever was necessary to enlighten us further. It is a great mistake for a man to go to one clinic after another without making a real study of any one. This course leads to general information, but it is often so confusing in the mass of detail that a surgeon cannot go home and put into practice the things he has learned.

I confined myself very largely to the Roosevelt, the New York, Mt. Sinai and Presbyterian Hospitals, sometimes going down to the Bellevue Hospital. The great work done by Charles McBurney, a member of the New York Surgical Society, in the early time, at the Roosevelt Hospital, on appendicitis, which Reginald Fitz of Boston, in 1886, was the first to describe, and the McBurney operation, for removal of a stone implanted in the terminal end of the common duct, were two of the many scientific contributions which added to McBurney's great reputation.

William T. Bull, a member of the New York Surgical Society, down in the old Chambers Street Hospital in New York, performed the first successful operations for gunshot wounds of the intestine. One of the celebrated surgeons of the time said that his success was a misfortune because it would lead other less able surgeons to make disastrous and hazardous attempts. Bull, like Dr. Maurice Richardson, of Boston, had few equals in surgical judgment.

Frank Hartley, a member of the New York Surgical Society, was one of the most gifted surgeons in New York, but for various reasons he never came quite up to the expectations of his many admirers.

Robert Abbe, a member of the New York Surgical Society, did most notable work in that early time, especially in intestinal surgery, stressing particularly, as I remember so well, the long lateral anastomosis for intestinal obstruction.

In the New York Surgical Society was one man, William S. Halsted, who

was to become famous as a teacher of surgery at the Johns Hopkins Medical School. Halsted has the distinction of having developed more surgeons than any other man of his time in America. He was a great writer and a great investigator.

At the New York Hospital were many brilliant men, of whom the leader at that time was Robert Weir, a member of the New York Surgical Society. Weir had an original mind and surgical imagination, and was a leader in advancing the surgical frontier.

I became a fellow of the American Surgical Association in 1899 when Weir was president of the organization. His presidential address in 1900 was on acute perforations of the duodenum, and his striking presentation of cases, and clear descriptions in relation to the pre-perforate symptoms which we now know to be those of chronic duodenal ulcer, impressed me greatly. They were graphic; they caught my imagination. When I came home I had several patients with acute perforation of the duodenum who gave pre-perforative histories almost identical with those in Weir's cases. I was encouraged to operate on some of the more serious chronic duodenal lesions, and was soon able to recognize and separate the chronic duodenal ulcer from the chronic gastric ulcer.

Lewis A. Stimson, a member of the New York Surgical Society, who wrote the splendid work on fractures and dislocations, was also on the staff of the New York Hospital.

At the Presbyterian Hospital, I remember best Andrew J. McCosh, a member of the New York Surgical Society. McCosh was one of the soundest surgeons in New York. I came to know him quite intimately and traveled abroad with him. His unfortunate death occurred in 1908 as the result of an accident with a runaway team of horses.

Virgil P. Gibney, a member of the New York Surgical Society, was one of the first Americans to carry sound surgery into the field of orthopædics, in a day when orthopædic treatment was largely a matter of concealing deformities by hanging on apparatus, and it was considered a good result when a patient eventually could escape from the hands of the surgeon in no worse condition than when he started.

Joseph Bryant, a member of the New York Surgical Society, of Bellevue Hospital, was an excellent lecturer and came into a great deal of prominence because of the operation that he performed, with W. W. Keen, on President Cleveland. Bryant was afterward President of the American Medical Association in 1907.

I have been greatly saddened by the death of Charles H. Peck, an intimate friend. Doctor Peck was a sound surgeon, a member of the New York Surgical Society. His life was blameless and his example one to be emulated. It would be idle for me to speak further before this association of one of its most loved members, whose personality and scientific work are so well known to you.

Time prevents my referring to many other men who did notable work.

I have always been grateful to the surgeons of New York, and wish here to acknowledge the aid and inspiration they gave me. And I have been thankful for the opportunities which I had of attending meetings of the New York Surgical Society. At first the meetings were held privately; fortunately, later, they were made accessible to visitors.

I shall not speak of the living members of the New York Surgical Society, but as I look around this audience it is a satisfaction to see so many men to whom I am indebted for surgical teaching and whose friendship I value highly.

Remarks of PRESIDENT BEER, introducing DR. ELLSWORTH ELIOT:

The next speaker on our program, one of our own members, has had the unique advantage of working with many of our original members, and many of the present active members have profited by the teachings that he has passed on to them from his early experience. Last year he was President of the American Surgical Association, and some years ago was president of this organization. He has always stood for the best in surgery and for high ethical standards. We look upon him in these matters as firm as the Rock of Gibraltar. It gives me the greatest pleasure to present Dr. Ellsworth Eliot.

# THE SEMICENTENNIAL ANNIVERSARY OF THE NEW YORK SURGICAL SOCIETY

BY ELLSWORTH ELIOT, JR., M.D.

OF NEW YORK, N. Y.

DOCTOR LUND has recalled the faces and the figures, and Doctor Mayo has faithfully portrayed the character of many of the original members of this association whom it was the privilege of a number of those present to love and admire. This Society certainly was conceived under very unusual conditions.. New Amsterdam, afterward New York, was always cosmopolitan. Situated between Boston, the hub of culture and of intellect on the North, and Philadelphia, the centre of intellect and culture on the South, this city soon lost whatever advantage it may have enjoyed from priority of birth, and it was not until the 19th Century was well along that it was again equal in numbers, if not in the quality of its population, to its neighbors.

One is rather apt to believe that the New York of to-day has not changed materially from the New York of the past; and in one particular this is true. New York has always been favored by representatives of many nationalities. In the old days of past generations we spoke of the Thompson Street negro, of the Italian of Elizabeth Street, of the Hebrew of Hester Street, and of the Chinamen of Mott Street. To-day these foreign nationalities of many lands are still represented here, though in different parts of the city, with the exception of the Chinaman who still inhabits Mott Street and has made that thoroughfare aristocratic.

The pedestrian on Fifth Avenue, as he wanders up Murray Hill, can scarcely realize that between 36th and 37th Streets the level of the Avenue is at least 20 feet below what it was originally, and perhaps some of you can remember the frame house and the florist shop on the eastern side of this portion of the Avenue, to the top of which outside a flight of wooden rickety steps led. The corner lot adjoining, now occupied by Tiffany, was vacant and in it we played baseball. Further up on Fifth Avenue, beyond and opposite to the reservoir, was another landmark; a two-storied frame house with a large willow tree on the edge of the sidewalk, and on the corner, adjoining, the fashionable Fifth Avenue market. The site of the present Savoy-Plaza Hotel was occupied by an extensive marsh, and years ago, one of the older managers of the Presbyterian Hospital told me that this was a favorite hunting ground for him and his friends, who shot birds in the brush on its edge. Above 59th Street, Manhattan Island was practically a wilderness. In looking over one of the books of the County Medical Association recently, I counted the number of doctors who lived on the West side of this portion of the city and found less than ten. It was known familiarly as "The Rocks," incapable of any extensive development. Now and then the City or a property owner would excavate a building plot or street by blasting away



with successive charges of powder the rock foundations. A somewhat larger number of doctors lived on the East side in "Yorkville," now 86th Street, for through this region the old Boston Post Road extended upward to divide near the Harlem River for Boston and Albany. The larger population was also accounted for by the greater fertility of the soil.

With this primitive condition the hospitals of the city closely corresponded. The two oldest hospitals were Bellevue and New York, both long established. For a number of years in the eighteen-seventies, the latter hospital was closed when it changed its location, the original building on lower Broadway having become infected with uncontrollable erysipelas. Presbyterian, Roosevelt and St. Luke's Hospitals, in their infancy, were geographical expressions rather than actual entities. Bellevue, even then, was political and democratic, while New York Hospital was aristocratic, and for a long time only members of New York's leading families were admitted as internes to its house-staff. I remember as a medical student talking with a friend who had succeeded in being appointed an interne to this hospital. He had just imparted this important information to a classmate and had met the rejoinder "Gee! but you must have had a pull!" The attending staffs of these hospitals were like so many interlocking directorates; no member had a continuous service. The maximum length of service during each year did not exceed three months and many had shorter periods. There were no assistant or associate surgeons and the fortunate candidate, when first appointed, was obliged to step from an inconspicuous dispensary position into the acutely active service of a ward. Members of the Medical Board were not only surgeons but general practitioners as well and did not refrain from indulging, even, in the practice of midwifery. One of the early presidents of this Society, connected with the New York Hospital, enjoyed a great influence in its conduct, which was ascribed to the fact that in the course of his fifty years of service he had delivered all the members of the Board of Trustees.

Now came the magical wand of Pasteur and of Lister and the birth of a new surgical era. It was precisely at this time that the New York Surgical Society came into existence, enthusiastic and eager to promote the advance of what was essentially a new science. Not without certain doubtings and arching of the eyebrows was antiseptic and afterward aseptic surgery placed on a sure foundation, a triumph for which, in this city, none deserve more credit than the original members of this Society. The marvelous advance in surgical technic left scarcely any organ or body cavity intact. The brain, the spinal canal, the thorax, the abdomen and pelvis and the genito-urinary organs were all included in the surgical domain. Then came the inevitable specialist who, one after another, appropriated the different surgical fields, in which even his medical colleague participated, who claimed the surgical treatment of empyaema. The justly celebrated internist, Francis Delafield, described in his didactic lectures the technic of incision and drainage with or without the excision of a rib for the relief of this condition. He emphasized the need of always operating with the patient in a sitting position, without a

general anæsthetic and advocated opening the abscess through a single incision and thereby avoiding infection of the thoracic wall which was certain to follow the method of gradually deepening the incision of the skin through the underlying muscle planes. Dr. George L. Peabody at the New York Hospital was once engaged in the removal of a rib when Doctor Markoe, one of the early presidents of this Society, walked into the operating room. Doctor Peabody turned to him and said: "Doctor Markoe, I suppose that you fully approve of the members of the medical staff operating upon cases of empyaema?" To which his colleague replied: "Doctor Peabody, the only operation that I consider members of the medical staff capable of performing is an operation of the bowels," and with that, he turned on his heel and left the operating room.

So advancing here, retracting there, this surgical Association has done yeoman work up to the present time, to the details of which our honored guests have referred. Unfortunately its founders and early members are scarcely represented in its present roster. No Parker, Van Beuren, Sands, Weir, Markoe, Bull, McBurney or Stimson is to be found in its present membership. In only one family, that of Gerster, has the mantle of the father descended upon the son. It is to be hoped in the future that the evidence of heredity will be more marked in its membership than is the case at the present time.

As the hospitals in New York have increased in size and number so has this Society expanded, and to-day it enjoys a membership larger than at any other time in its existence. The consequent clinical material for study, research and report is enormous and alone argues well for the continued success of the Society. The question arises whether, in the future, its usefulness can be increased in any way. A fortunate step was taken in holding the annual conjoined meetings with the Philadelphia College of Surgeons which have promoted contact with surgical thought and have encouraged surgical intimacies. It is, of course, impracticable to arrange similar meetings at a greater distance from New York, but it is still perfectly possible to invite distinguished surgeons, as we have to-night, to present interesting and important surgical topics. In the past, discussion of surgical topics, especially critical discussion between individual members, has not always been generous. This important and valuable feature of the meetings should be encouraged and stimulated. I believe that by these different means the work of this Society can be made even more valuable in the future and that it will continue to exert a stimulating influence on the development of the Science of Surgery. May the good name and fair reputation of the New York Surgical Society be always maintained!

# EVALUATION OF CARDIAC AND CIRCULATORY STIMULANTS FOR SURGICAL PATIENTS

By ALFRED E. PHELPS, M.D.

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WITH the exception of hypnotics and narcotics, no class of drugs is probably more frequently administered to surgical patients than is the group comprising cardiac and circulatory stimulants. In view of the fact that practically all these stimulants and so-called stimulants have been the subject of painstaking experimentation by competent investigators, we possess at the present time a fairly accurate knowledge of the action of these drugs upon the circulatory system.

It is the purpose of this paper to assemble the results of these researches and to present the relative values of the drugs commonly employed as cardiac and circulatory stimulants in surgical shock.

*Epinephrine*.—Ether anæsthesia distinctly diminishes the response to minute amounts of epinephrine, and hæmorrhage also acts to lessen this response to a degree proportional to the lowering of the blood pressure. Three to four times the amount of epinephrine sufficient to produce a blood-pressure rise of ten to fifteen millimetres of mercury under normal conditions may be without effect in the exsanguinated; but the response to a large dose is uninfluenced either by ether or by hæmorrhage.<sup>1</sup>

Experimentally, the administration of epinephrine both intravenously and subcutaneously increases the cardiac output of normal dogs 10 to 50 per cent. However, the duration of the action is brief (less than seven minutes) and, furthermore, the cardiac output in many instances shows a tendency to return to a point below the original output, once the brief effect of the drug has disappeared. In view of these facts, it would seem that epinephrine, if used at all in the treatment of circulatory failure, should be employed cautiously and only as a temporary measure to uphold the patient's circulation until more valuable procedures, such as blood transfusion, can be employed.<sup>2</sup>

It has been found experimentally that the undesirable after-depressing effects of epinephrine on the blood pressure can be counteracted by small doses of barium chloride which strengthen the heart's action and sustain high blood pressure for some time.<sup>3</sup>

*Caffeine*.—It has been recently demonstrated by experiments on dogs, in which the response to stimulants is similar to that in man, that caffeine sodio-benzoate in therapeutic doses has no beneficial action on the cardiac output. In fact, the cardiac output per minute is actually diminished, and the greater the dose the greater is the reduction of the output.<sup>4</sup>

*Camphor*.—Camphor-in-oil, the commonly used circulatory stimulant in surgical shock, depresses the isolated heart both of the frog and of the rabbit.

It acts directly on the cardiac muscle and also dilates the coronary vessels. To anesthetized animals camphor does not, however administered, cause a rise of blood pressure unless the dose is sufficient to cause convulsions. After removal of the cerebral hemispheres, no rise of blood pressure takes place even with doses up to one gram per kilogram.<sup>5</sup> Bodo finds that camphor dilates the heart,<sup>6</sup> Winterberg states that camphor is a vasodilator.<sup>7</sup> Its action in this respect has been corroborated by others. Heathcote from his experiments concludes: "That there is no convincing pharmacological evidence that camphor possesses any value whatever as a cardiac or circulatory stimulant. Its values, if any, for this purpose in man should be established or disproved by more exact clinical observation."<sup>8</sup>

*Ephedrine.*—Ephedrine, the active principle of the Chinese drug, ma huang, is not infrequently employed as a substitute for epinephrine. Its use is based on the fact that the substances are closely related, chemically and physiologically. The principal effect of ephedrine on the heart is that of stimulation of the accelerator mechanism, exerted simultaneously on the ganglia and nerve endings. Large doses depress the heart muscle and cause a fall in blood pressure. Constriction of the blood vessels supplied with vasoconstrictor nerves also occurs and in man this seems to be the most prominent action.<sup>9</sup>

With reference to its action as a circulatory stimulant, Chen and Schmidt state: "Ephedrine has been rather a disappointment. If ephedrine is given with epinephrine, ephedrine may prolong the effect of the stronger stimulant. The tendency of cardiac depression can be minimized by improving the coronary circulation by means of epinephrine and saline infusion or transfusion of blood before ephedrine is given. Ephedrine should not be injected intravenously in cases of profound shock if epinephrine fails to elicit a response, for it can do no good and may do harm. Ephedrine is certainly not to be regarded as a specific for shock. Its actual usefulness remains to be determined clinically."<sup>9</sup>

A comparative study of the effects on dogs of the dosage, the consistency and the duration of action of epinephrine and ephedrine reveals the following: Intravenously, epinephrine increases the circulatory minute volume more consistently than ephedrine, but it reduces the duration of action two-thirds. Subcutaneously, epinephrine and ephedrine have the same effect on the consistency and duration of action of the cardiac output. Epinephrine usually increases the pulse rate of normal dogs, whereas ephedrine produces the opposite effect. In these experiments epinephrine was used in doses that correspond to large therapeutic doses for adults, whereas the amount of ephedrine used was equivalent to an average dose for an adult patient. Because ephedrine is less variable in its action, and because after epinephrine a greater secondary depression frequently follows the initial increase in cardiac output, it would appear that ephedrine is the better drug in the treatment of circulatory collapse.<sup>10</sup> Ephedrine has been used recently in experimental shock by Smith who comments, "The blood rose to 90 mm.

mercury during the injection only to fall to shock levels within fifteen minutes." <sup>11</sup>

*Pituitrin.*—Pituitrin is a drug not infrequently resorted to for patients in shock. It has a definite vasoconstrictor effect on the vessels in general, but it dilates the heart to a very high degree immediately after its administration. This action, however, is transitory.<sup>12</sup> With reference to its use in shock, early injection of pituitary extract in physiological saline or in glucose solution often elevates the blood pressure to a normal level, but the effect never lasts more than one hour, often less, and its administration during the secondary fall of blood pressure is of no permanent value. The intravenous injection of 6 per cent. gum arabic solution in physiological saline alone, or with pituitary extract, fails to produce more than temporary results.<sup>13</sup>

*Strychnine.*—For many years strychnine has been used by clinicians on the assumption that it has a tonic effect on the human heart. Bodo found no such action in heart-lung preparations of the dog.<sup>14</sup>

*Alpha Lobelin.*—Alpha lobelin is occasionally used as a cardiac as well as a respiratory stimulant in moribund patients. Experiments show that this drug raises the blood pressure markedly, but that its effect when administered to animals moderately depressed persists for only about five minutes, while in deeply depressed animals the blood pressure is actually lowered by doses which, in less degrees of depression, will raise the blood pressure.<sup>15</sup> In addition, experimentally this drug commonly induces a 2:1 heart-block after either large or small doses, and this action persists for some forty-five minutes after intravenous injection.<sup>16</sup>

*Glucose-Insulin.*—The glucose-insulin treatment of shock first advocated by Fischer has been shown by Padgett and Orr <sup>17</sup> to be no more beneficial than treatment with a hypertonic solution of glucose or sodium chloride. With reference to this form of treatment Andrews and Reuterskiold <sup>18</sup> go still further and say: "That the use of insulin and glucose in patients who are suffering from post-operative conditions and are, therefore, dehydrated is a highly dangerous and useless procedure. In toxic conditions fluids are fixed by colloids and are not available for physiological purposes. For this reason the "free" water in the organisms is reduced even more than the total water. This fixation of "free" water is physiologically equivalent to dehydration. Since patients in this condition are starved and thirsty they need glucose and water. Insulin, on the other hand, tends to lower still further the already low blood sugar. In addition, it is known that surgical shock causes passage of fluids from the blood stream to the tissues. Insulin exaggerates this condition, thus producing a vicious circle. In other words, the more the blood is concentrated the more insulin acts and the more the blood is concentrated."

*Digitalis.*—Accurately controlled experiments by Bodo clearly demonstrate that digitalis increases cardiac tonus, that is, enables the heart to expel the same amount of blood as before, with a smaller heart volume, when the

rhythm, venous return and arterial resistance are unchanged.<sup>6</sup> Digitalis furthermore causes a general constriction of the vessels, with a consequent decrease of the total capacity of the vascular system, thereby increasing venous return—an effect urgently demanded in surgical shock.

Pardee<sup>19</sup> has shown that to produce a prompt and marked effect with digitalis large doses of the intravenous preparations, such as digitan solution, digifolin or digilin, must be given. An adequate dose for this purpose consists of one minim of the solution per pound of the patient's weight, that is, eight ampoules for a patient weighing one hundred and twenty pounds, ten for one weighing one hundred and fifty pounds, and so on. This is one half the therapeutic dose. He directs that it be given slowly over a period of two to three minutes, so that it becomes well mixed with the patient's blood and therefore does not arrive in the heart at one time, and states that while the intravenous administration of this dose of the digitalis preparations does not produce instant effect, it does produce some effect within fifteen minutes, and reaches its maximum effect in from one to two hours after administration.

#### SUMMARY

1. Epinephrine increases the cardiac output for a brief period (less than seven minutes) with a tendency in many instances to return to a point below the original output.
2. Caffeine actually diminishes the cardiac output.
3. Camphor-in-oil depresses the cardiac musculature and dilates the coronary vessels.
4. Ephedrine stimulates the accelerator mechanism—large doses depress the heart muscle and cause a fall in blood pressure.
5. Pituitrin constricts the vessels in general but dilates the heart to a very high degree immediately after its administration.
6. Strychnine has no tonic effect on the heart.
7. The use of insulin in shock is harmful.
8. Digitalis, in adequate dosage, is a cardiac tonic and a general vaso-constrictor, the action of which is dependable, pronounced and sustained.

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# TREATMENT OF PITUITARY TUMORS: THE RÔLE OF THE RÖNTGEN-RAY AND OF SURGERY THEREIN

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FEW neurosurgeons believe in the efficacy of the Röntgen-ray in the treatment of adenomas of the pituitary gland. Some have given it a brief trial before operation, and many use it after operation. In 1926 I<sup>1</sup> reported two cases of pituitary tumor in which the visual fields and visual acuity had been restored to approximately normal for periods of three and two years respectively by Röntgen-ray treatment. These cases and a review of the literature led to the following deductions. 1. That Cushing's<sup>2</sup> statistics showed that 20 per cent. of pituitary adenomas were cystic, and that about 20 per cent. of his patients conserved useful vision for more than five years after operation. The remaining 80 per cent. either did not regain useful vision, or had recurrences after a period of about two years. These figures suggested that the results of surgery were lasting only when a cystic tumor was encountered. 2. My cases and others in the literature showed excellent results for periods of from two to thirteen years after Röntgen-ray treatment. It must be assumed that these were solid tumors, as cysts would not respond to the Röntgen-ray, and therefore there was reason to believe that four out of five pituitary adenomas could be treated more safely and with more lasting results by Röntgen-ray than by surgery. The subsequent history of the two patients who were the basis of the previous report, and the records of three others who have been under observation for more than two and a half years, have been studied to determine their bearing on the conclusions previously drawn.

## CASE REPORTS

CASE I.—*Restoration of normal visual acuity and fields for five years by Röntgen-ray treatment. Recurrence, failure of Röntgen-ray, temporary improvement following operation, and death seventeen months after recurrence.*

The detailed record is given under Case I of the previous report.<sup>1</sup> L. L., a woman aged forty-five years, seen in February, 1922, complained of failing vision for two years. Examination showed V. O. D. 15/70, V. O. S. fingers at one metre, incomplete bitemporal defects in the visual fields, with loss of central vision on the left and a relative central scotoma on the right. There was paresis of the left sixth nerve and of the right third nerve. Röntgenograms showed destruction of the floor and dorsum of the sella. Under Röntgen-ray treatment the ocular palsies disappeared, and visual acuity and fields returned gradually to normal. Figure 1 shows the record of December 13, 1926, nearly five years after treatment was started. Recurrence was noted early in February, 1927, and a beginning bitemporal loss was charted on February 24. She was given Röntgen-

<sup>1</sup> Towne, E. B.: Röntgen Ray Treatment of Pituitary Tumors, Arch. Neurol. & Psychiat., vol. xv, p. 92, January, 1926.

<sup>2</sup> Cushing, Harvey: Les syndromes hypophysaires au point de vue chirurgical, Rev. Neurol., vol. xxxviii, p. 779, June, 1922.



ray treatments in March, April and May. Visual acuity and fields failed rapidly. There was a complete bitemporal hæmianopsia April 5, with V. O. D. 20/50, V. O. S. 20/70. June 6, the field of the left eye had disappeared (Fig. 2). June 13, 1927, by transphenoidal approach, a small cyst containing about three or four cubic centimetres of chocolate colored fluid was evacuated, and fragments of solid tumor were curetted out. Improvement was rapid, so that when she left the hospital, fifteen days after operation, both nasal fields were normal, there was some restoration of temporal fields on both sides, and V. O. D. was 15/40, V. O. S. 15/70. The eyes continued to improve for three months after operation (Fig. 3), and then slowly failed. In January, 1928, the condition

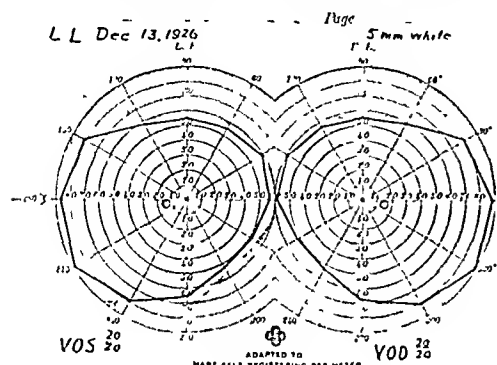


FIG. 1.

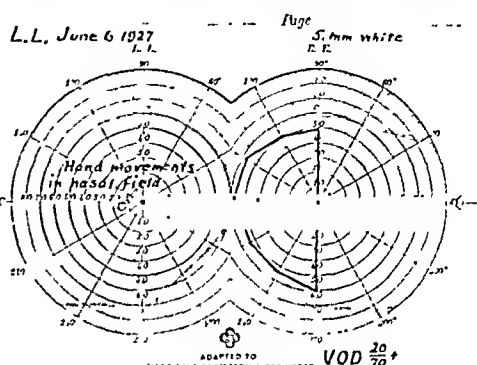


FIG. 2.

FIG. 1.—Case I. Visual fields five years after first Röntgen-ray treatments.

FIG. 2.—Case I. Fields after failure of second Röntgen-ray treatments, and before operation.

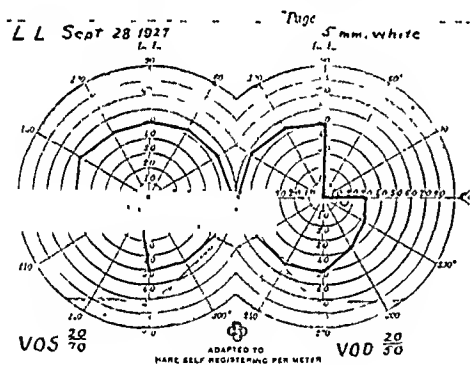


FIG. 3.

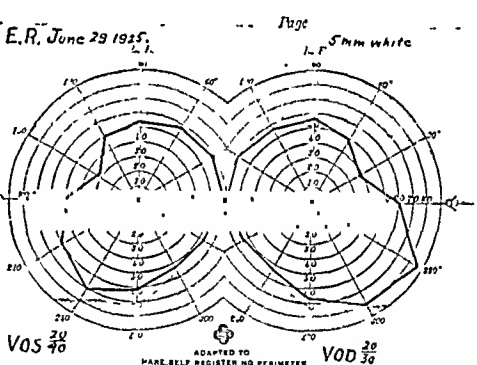


FIG. 5.

FIG. 3.—Case I. Three months after operation.

FIG. 5.—Case II. Visual fields two years after first Röntgen-ray treatments.

was again as in Fig. 2. The patient died July 7, 1928. Autopsy showed that the huge tumor (Fig. 4) was riddled with small cysts, but that at least four-fifths of the bulk was solid.

The Röntgen-ray gave an extraordinarily good result in this case. After a five-year cure, the recurrence was apparently due to the development of numerous small cysts in the tumor. There could, therefore, be no response to further Röntgen-ray, and surgical evacuation of the presenting small cyst resulted in only temporary improvement.

*CASE II.—Restoration of normal visual acuity and fields by Röntgen-ray treatment. Recurrence after two years, eight months; failure of Röntgen-ray. Prompt improvement after evacuation of cyst, lasting to date, three years after operation.*

The complete record is given under Case II of the previous report.<sup>1</sup> E. R., a man aged forty-two years, was seen in May, 1923, complaining of loss of vision for two

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months. Examination showed absence of the left temporal field, with a relative central scotoma, V. O. D. 15/20, V. O. S. 15/70, and an enlarged sella. He received twelve series of Röntgen-ray treatments between May, 1923, and June, 1924. After three months V. O. S. was 20/40 and the left temporal field had widened to  $50^{\circ}$ . In June, 1925, V. O. D. was 20/30, V. O. S. 20/40, and there was a small defect in each upper temporal field (Fig. 5). In spite of instructions to report once a month for perimetric examination, he disappeared until February 11, 1926, when he stated that vision had been failing for six weeks. Examination showed V. O. D. 20/100, V. O. S. 20/70, and extensive defects in both temporal fields. Three series of Röntgen-ray treatments at monthly intervals resulted in further loss. April 28, the temporal fields were entirely gone, and V. O. D. was 8/200, V. O. S. 18/200, due to central scotomas (Fig. 6). May 4, 1926, a trans-

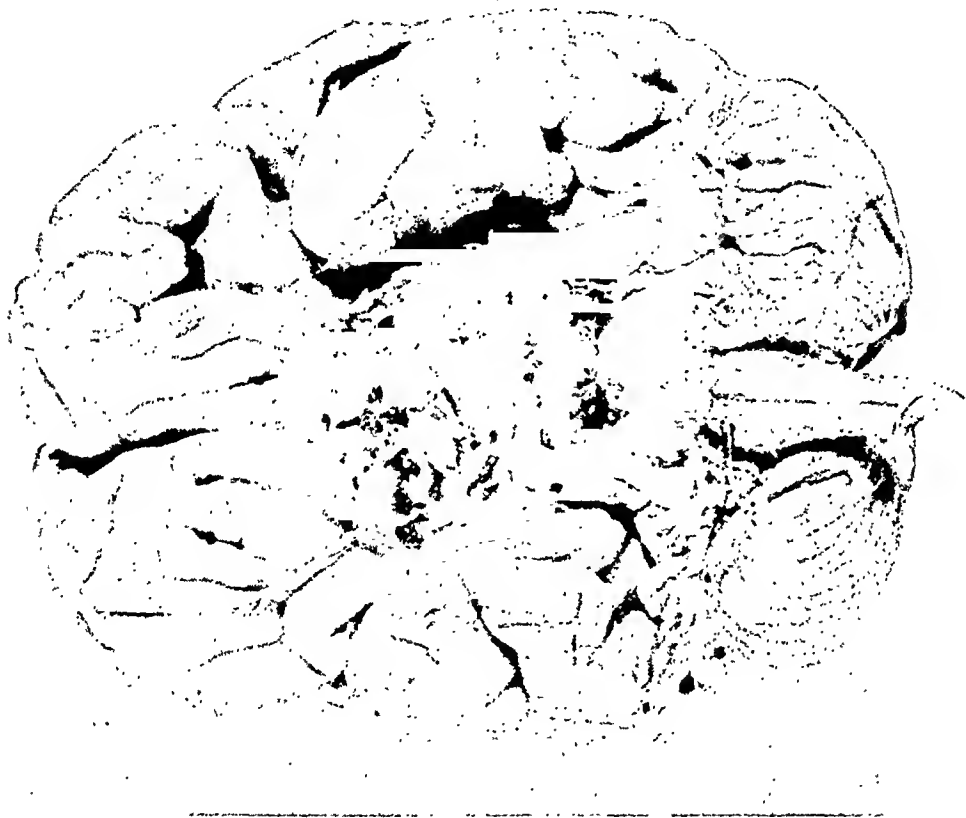


FIG. 4.—Case I. The tumor.

sphenoidal operation was done. The exposed dura looked blue. A needle was introduced and nine cubic centimeters of thin, brownish fluid were aspirated. The dura was opened, more fluid was evacuated, and a few fragments of tumor were curetted out. On the next day he could read newspaper print with the right eye. Fifteen days after operation, V. O. D. was 20/30, V. O. S. 20/70, and the visual fields were as shown in Fig. 7. Frequent reexaminations up to the present time (June, 1929), have shown no important change. There has been no further treatment of any kind. He works steadily at his trade of watchmaker.

This case confirms in every detail the hypothesis outlined above. The adenoma was apparently solid at first, and the favorable response to Röntgen-ray lasted for nearly three years. Then the tumor became cystic, and did not respond to further Röntgen-ray treatment. Surgical evacuation of the cyst gave an excellent and apparently lasting result. It is possible that the second series of Röntgen-ray was persisted in too long, and that wider visual fields

might have been saved if the operation had been done a month or two earlier. However, useful vision has been retained for three years since operation.

CASE III.—(I am indebted to Dr. Emile F. Holman, of San Francisco, for permission to report this case.) *Bitemporal hæmianopsia not improved by Röntgen-ray treatment; condition stationary three and one-third years later; operation refused.*

O. B. E., a man aged thirty-two years, was seen in consultation with Dr. Emile F. Holman, February 25, 1926. He had been referred to Doctor Holman by Dr. K. H. Martzloff, of Portland, Oregon. Loss of the temporal field of the left eye was noted by the patient in April, 1925. Examination at that time showed a positive Wassermann

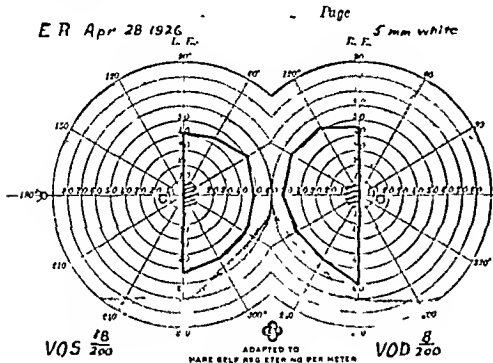


FIG. 6.

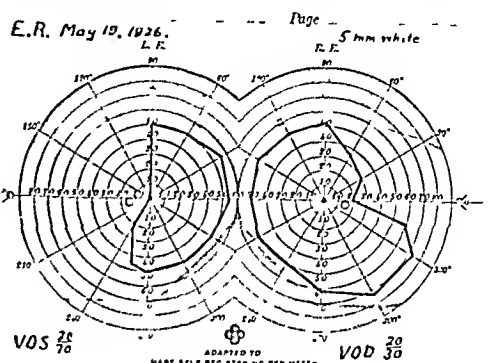


FIG. 7.

FIG. 6.—Case II. Fields after failure of second Röntgen-ray treatments, and before operation.  
FIG. 7.—Case II. Two weeks after operation.

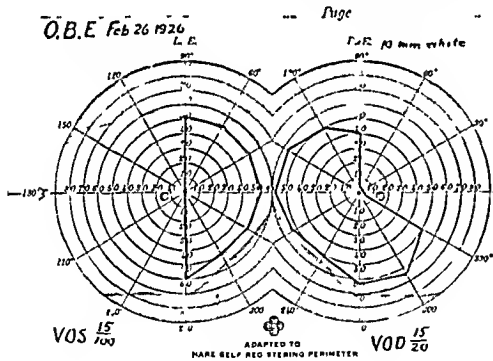


FIG. 8.

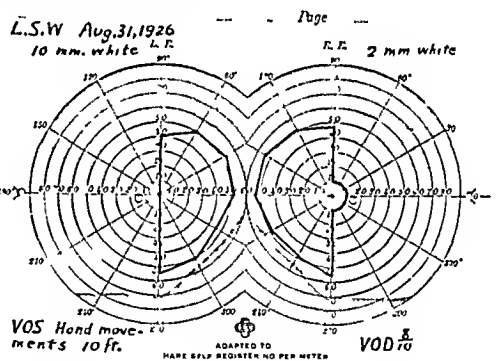


FIG. 9.

FIG. 8.—Case III. Visual fields before Röntgen-ray treatments.

FIG. 9.—Case V. Visual fields before Röntgen-ray treatments.

reaction in the spinal fluid, an enlarged sella turcica, bitemporal hæmianopsia for colors, a large scotoma in the left temporal field involving the central area, V. O. D. 15/20, V. O. S. 15/200, blurring of the disc margins and tortuous retinal veins (Dr. A. B. Dykman). Under vigorous antiluetic treatment the visual fields shrank, and in January, 1926, Doctor Dykman reported a complete bitemporal hæmianopsia except for an island in the lower right temporal field. Doctor Holman's notes in February, 1926, added the fact that there had been diplopia for six months. The röntgenogram showed an enlarged sella, V. O. D. was 15/20, V. O. S. 15/100, and there was a nearly complete loss of temporal fields (Fig. 8). I advised Röntgen-ray treatment, warning the patient that operation would be indicated if there were further loss, or no improvement after about five months. He was treated once a month for twelve months. There was no change, except that headache and diplopia disappeared, and the lower temporal field of the right eye was lost. The patient was seen by Doctor Holman in June, 1927. Examination showed that the bitemporal loss remained complete, and that V. O. D. was 20/20,

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V. O. S. 15/100. Operation was advised and refused. Doctor Martzloff reported in June, 1929, that the patient had not consulted him since 1927, but that he was carrying on his work, and that his vision was sufficient to allow him to drive an automobile.

This case is complicated by cerebrospinal syphilis, but the ballooned sella is positive proof of an adenoma of the anterior lobe. It seems probable that the tumor is partly cystic, and that further growth of the solid portion has been checked by the treatment. The patient has undoubtedly run a great risk of losing useful vision by refusing operation.

*CASE IV.—Blindness for three months. Slight response to Röntgen-ray; no response to surgery.*

W. L. B., a man aged fifty years, was seen April 30, 1926. Ten years previously he noticed loss of both temporal fields, but he retained useful vision until eighteen months before entry, when he had to stop driving an automobile. He had been totally blind for three months. Examination showed an enlarged sella with destruction of the dorsum, V. O. D. and V. O. S., hand movements in nasal fields, and optic atrophy. He received eight series of Röntgen-ray treatments at monthly intervals. There was slight improvement in the vision of the left eye, so that after the fourth series he could count fingers, and avoid the furniture in walking about a strange room, but it lasted for only a few weeks. Surgical treatment was advised, but refused until June, 1927, when a transsphenoidal operation was done. No cyst was found, and vision did not improve. The patient remains blind at the present time, two years after operation.

This case is unimportant and is included only to record all experiences. The optic atrophy was too advanced to allow a result from any procedure, and the operation was undertaken only because of the slight improvement following the first few Röntgen-ray treatments.

*CASE V.—Bitemporal hemianopsia with loss of central vision in left eye, cured by Röntgen-ray. Normal visual acuity and fields two years, ten months later.*

L. S. W., a woman aged sixty-four years, was referred by Dr. Otto Barkan, of San Francisco, September 1, 1926, with the diagnosis of pituitary tumor. She had noticed loss in both temporal fields and failing vision in the left eye for six months. The Röntgenogram showed a deep sella with destruction of the dorsum and of the left anterior clinoid process. Perimetric examination by Doctor Barkan showed a bitemporal hemianopsia, but it should be noted that he used different-sized test objects for the two eyes, and that the patient could see large objects in the right temporal field (Fig. 9). V. O. D. was 8/10, V. O. S., hand movements at ten feet. Five series of Röntgen-ray treatments were given at intervals of a month. The patient said that her vision was better immediately after the fourth series, and examination before the fifth series showed a beginning return in both temporal fields, but no improvement in visual acuity of the left eye. She did not report to Doctor Barkan again until May 3, 1927, three months after the last treatment, when he found V. O. D. 8/10, V. O. S. 6/10, and nearly normal fields to 1 mm. disc. In July, 1928, the fields were complete and vision was 10/10 in each eye (Fig. 10). At the present time (June, 1929), the visual acuity and fields remain normal.

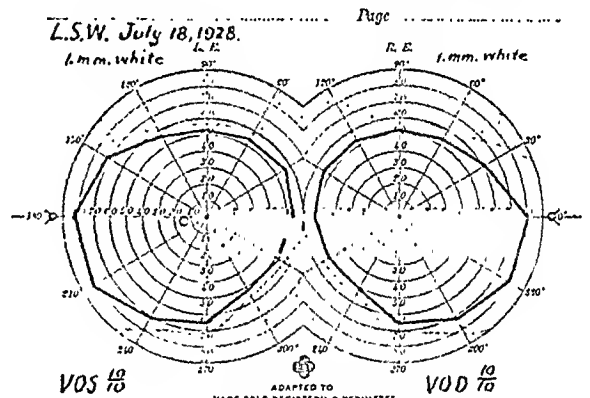


FIG. 10.—Case V. Fields two years after Röntgen-ray treatments.

In this case treatment was stopped after the fifth series, when the first slight improvement appeared. This was done because of our experience in Case II, in which, although the visual fields widened after the third series, nine more were given in the next ten months, and it seemed possible that overtreatment might have caused the cystic degeneration in the tumor.

*Technic.*—Most of the Röntgen-ray treatments in these cases were given by Dr. W. E. Chamberlain and Dr. R. R. Newell at Stanford University Hospital. As the technic was gradually developed certain changes were made, but the methods used in Case V are representative of what they now advise and practise. Doctor Newell has kindly furnished the following summary of the treatment in this case: "Mrs. W's program of X-ray treatment was 200 R filtered X-ray ( $\lambda$  effective equals 1.17 Angstroms) to each of five areas, each temple, forehead, vertex and occiput, given every month. These were divided among three days on each monthly series. The areas were  $9 \times 9$  cm., and the tube distance 31 cm."

*Discussion.*—The only reason for presenting such a small series of consecutive cases would be that the results, observed over a sufficiently long period, show clearly that the treatment employed is preferable to that generally used. Does a review of these five cases indicate that the initial use of Röntgen-ray gave better results than might have been expected from the initial use of surgery? Knowing that most, if not all, solid tumors show recurrences within two years, it seems highly improbable that normal fields and vision could have been restored for five years in Case I by any operative method. The patient's poor condition, and the size of the tumor as revealed by areas of calcification, caused me to refuse to undertake surgery and to try Röntgen-ray treatment, with little hope of a favorable result. In Case II the result of Röntgen-ray therapy was excellent for nearly three years, and might have lasted indefinitely if the treatments had not been kept up too long, if it is assumed that overtreatment caused the cystic changes in the tumor. Perhaps primary operation would have also given, at a greater risk, a cure for nearly three years, but there is no reason to believe that the cystic degeneration, which made the case so favorable for surgery, would have taken place without Röntgen-ray treatment. If there is a cystic tumor, as suspected in Case III, primary operation would have been preferable. As soon as it was seen that conditions were remaining stationary under Röntgen-ray treatment, operation was strongly urged, and refused by the patient. The subsequent course shows that the chance of saving useful vision was not compromised by the Röntgen-ray treatment. Case IV proves nothing, as there was no important result from either method of treatment because of advanced optic atrophy. In Case V, the perfect result to date, two and three-quarters years after treatment was started, is better than one would expect from surgery. It appears, therefore, that of the five cases, in one the condition was too advanced to be helped by any therapy, in another the patient refused surgery when Röntgen-ray failed, and in three the results of Röntgen-ray treatment were better and safer than could have been expected from surgical treatment. Of these three, one

## TREATMENT OF PITUITARY TUMORS

eventually required surgery, which did no good, and another developed the cystic changes in which surgery gives brilliant results.

Numerous scattered reports of pituitary adenomas favorably influenced by the Röntgen-ray are appearing in the literature. Physicians are beginning to try this method of treatment. It will be unfortunate if the cases are not selected carefully. Only adenomas of the anterior lobe, which enlarge and destroy the sella, are amenable to Röntgen-ray therapy. Other tumors in the region of the chiasm may give the characteristic picture in the visual fields, but not the changes in the sella, and none of these will respond to the Röntgen-ray. There should be thorough coöperation between the ophthalmologist, Röntgenologist and neurosurgeon in the treatment of pituitary adenomas. A satisfactory method is to insist that the patient report for perimetric examination before each treatment. Thus the situation from month to month is known to all concerned, and the question whether to continue the Röntgen-ray treatment or to resort to surgery is open to consideration at these intervals. A result is not to be expected from one or two series of treatments. In Case I there is no accurate information beyond the patient's statement that she could read large type after four months, but in Case II the perimetric examinations showed improvement after three months, and in Case V after five months. It would appear safe to continue with Röntgen-ray, provided there is no loss, for at least six months before resorting to surgery. The present rather general practise of operating on pituitary adenomas and following immediately with Röntgen-ray treatment for many months is most undesirable. The two methods of therapy must be used separately, if we are to know what each can accomplish. It is not to the disadvantage of the patient to use them one at a time, for, if one fails, the other can be resorted to immediately.

The most important question which remains unsettled is whether the 20 per cent. of patients in Cushing's statistics who retained useful vision for more than five years after operation, represent the same group as the 20 per cent. in whom cystic tumors were found at the original operation. This can be settled only by the records of a clinic which has operated on a large series of cases and carefully followed the late results. If this be true, it would clinch the argument, and show that only the cystic tumors, which will not respond to Röntgen-ray, should be operated on.

### CONCLUSIONS

1. Eighty per cent. of pituitary adenomas are solid, and 20 per cent. are cystic.
2. Twenty per cent. of patients retain useful vision for more than five years after operation; 80 per cent. show no improvement or, after more or less marked improvement, have recurrences after about two years.
3. Operative treatment of pituitary adenomas has a mortality ranging from 7 per cent. upward; Röntgen-ray treatment has no mortality.
4. Cases are reported which illustrate long-standing favorable results

from Röntgen-ray treatment, and show that if the result is not good, a cystic tumor, favorable for surgery, may be diagnosed.

5. The present custom of following surgery immediately with Röntgen-ray treatment confuses the issue. The two methods may be used separately without jeopardizing the patient's chance for a cure.

6. It is proposed that all pituitary adenomas be treated by Röntgen-ray under the observation of the ophthalmologist and the neurosurgeon, that the treatment be stopped as soon as improvement begins, and that surgery be undertaken short of six months only when visual acuity and fields recede under Röntgen-ray treatment.

# GIANT CELL TUMOR OF THE SPINE \*

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THE following report of giant cell tumor of the spine merits recording for three reasons. First, it is relatively uncommon in the spine; second, its diagnosis is not easily made, and, finally there is a marked destruction with collapse of the affected vertebra.

D. G., male, white, age twenty-seven, married, was brought to the University of Chicago Clinic May 16, 1928, on account of pain in the left groin and lower part of the back which had existed for nearly five months. There was no injury preceding the development of the trouble. It was a dull ache at that time that did not interfere with his sleep at night or his activities during the day. For the last few days, he began to complain of pain in the left hip and back so severe that he could not sleep. He walked the floor most of the night; during the day, however, the pain did not bother him. Nearly two months later, while getting into a wheel chair, he was struck with an acute pain and spasm of the lumbar muscles on the right side. The pain caused him to perspire freely: he claimed that it felt as if something had become loose in his back, and sent burning sensations down both legs and scrotum. Abdominal rigidity soon developed and for the last twenty-four hours he had been unable to urinate and defecate. In the evening, he began to complain of burning sensation in the scrotum and buttocks with pain and tenderness on pressure over the first and second lumbar vertebrae. His temperature rose to 100.2 F. Total leucocyte count was 17,000 with 84 per cent. polymorphonuclears. On examination, the patient was feverish. He complained of incontinence, inability to move the bowels, numbness of the right half of the abdomen above the pubis and weakness of both legs. Voluntarily the abdomen and back muscles were held in a rigid state. There was slight stiffness and tenderness of the spine especially over the first lumbar vertebra with spasm of the lumbar muscles. The right hip showed marked limitation in flexion, extension and adduction. Abduction was impossible. Internal and external rotations were slightly limited. The left hip had practically a normal range of motion. Both legs were weak. Active movements of the right knee were impossible; the left could not be flexed but could be extended. The patellar tendon reflex was absent on the right and weak on the left. Both knee kicks were absent. Achilles tendon reflex and abdominal reflexes were absent. Cremasteric reflex was negative on the right and weakly positive on the left. There was a slight diminished sensation to touch downward from the right groin.



FIG. 1.—Before operation. Röntgenogram taken July 6, 1928. Antero-posterior view. Note the destruction and collapse of the body of the first lumbar vertebra and the destruction of the left vertebral arch. The articular surfaces are preserved. No new bone production.

\* This work has been conducted under a grant from the Douglas Smith Foundation for Medical Research of the University of Chicago.



Sensation to cotton, pinch and pressure was normal over both legs. There was an anesthesia for touch around the penis, perineum and scrotum which reached down on the medial side of the right thigh to the extent of four fingers. On the left, this extended



FIG. 2.—July 6, 1928. Lateral view. The site of the lesion is indicated by an arrow.

were of short duration it was felt that such an operation should be done as soon as possible. Exploratory laminectomy was performed July 4, 1928, under ethylene anesthesia.

The spines and laminae of the twelfth dorsal, first, second and third lumbar vertebrae were removed. Immediately upon removing the spinous process and laminae of the first lumbar vertebra a purple, dark mass came into view on the dorsal aspect of the dura mater. Under the spinous processes, this extended as low as the second lumbar and as high as the twelfth dorsal, beyond which limits normal dura mater was seen. The mass was easily separated from the dura to which it was not attached; and extended into the body of the vertebra, which was eroded and destroyed, and invaded the muscular tissue. The lateral boundaries were found and freed, but it was impossible to remove completely the tumor lying in front of the spinal cord. It was reported by the pathologist to be benign giant cell tumor. (Fig. 3.) The usual closure of the wound was made. Convalescence was uneventful, and the patient was dismissed on February 16, 1929. As a precautionary measure, a course of six deep X-ray was carried out. There was



FIG. 3.—Histological appearance of the tissue removed at operation showing numerous giant cells of the epulis type, and a markedly hemorrhagic stroma.

## GIANT CELL TUMOR OF THE SPINE

marked improvement in movement and sensation although the urinary retention still persisted. Two months prior to dismissal, a swelling appeared on the back to the right of the first and second lumbar vertebrae. This was quite soft in consistency and corresponded to the area of slightly increased fibrillary densities as seen in the subsequent röntgenograms. (Figs. 4 and 5.) At the time of discharge, he was able to walk fairly well and for considerable distances with the aid of spinal brace and cane. There was a slight sacral anæsthesia present. Although he was able to void spontaneously, there was still sufficient urinary retention to necessitate routine catheterization three times a day. Röntgenograms of the spine at this time showed disappearance of the fine fibrillary density (ossification) about the body of the first lumbar vertebra and the left transverse process of the second lumbar vertebra. With this there was slight anterior displacement of the lumbar vertebrae causing an increase in lumbar lordosis and dorsal kyphosis. A slight decrease in the space between the twelfth thoracic and second lumbar vertebrae was also noted as if increase compression of the body of the first lumbar vertebra had taken place. (Figs. 6 and 7.) July 28, 1929 (one year after the laminectomy) he returned for re-examination and was found to be free from the sacral anæsthesia although the urinary retention was still persistent. There was a marked limitation of motion of the lumbar spine. The place of the soft swelling to the right of the first and second lumbar vertebrae was now occupied by a slightly smaller mass which was of bony consistency. On röntgen-ray examination, this mass showed marked ossification which suggests cessation and healing of the process. (Figs. 8 and 9.)



FIG. 4.—After operation. Röntgenogram taken seven weeks after the laminectomy antero-posterior view. Note the fine, fibrillary lines of increased density (ossification) about the body of the first lumbar vertebra.



FIG. 5.—Lateral view. Note angulation at the dorso-lumbar region, and the displacement of the vertebrae.

In reporting a case of giant cell tumor of the vertebra, LEWIS in 1924, reviewed briefly the histories of sixteen cases gathered from the literature. The following cases have also been found:

ROGERS (1903), 1 case. This was a male twenty-two years of age, who started to have pain in the small of the back in 1899. Three years later, a tumor was discovered occupying and involving the spinal lumbar region. Biopsy of this mass was made and reported by Doctor Brooks as typical giant cell sarcoma. Signs of

paralysis appeared and rapidly increased. Injection of pure erysipelas toxins was begun but had to be discontinued three months later as the reaction became violent. There was a complete motor and sensory paralysis below the waist and incontinence of urine and feces. He was in a pitiable and hopeless condition. Two months later, however, improvement

began to occur, and eight months after the biopsy, all the distressing symptoms had disappeared. The tumor in the back was still present and had slightly decreased in size, and the patient had slight night frequency of 5-6 urinations. He was able to sit up and walk about.

CAMURATI (1927), 1 case. This was a male twenty-five years old who was seen in 1913 complaining of pain in the neck subsequent to sudden turning of the head to one side. On examination, there was found marked spasm of the muscles of the neck and pronounced tenderness at the second cervical spine. Sensibility and reflexes were normal. Röntgen-ray examination of the cervical spine disclosed fracture at the base of the notch of the epistropheus with anterior luxation of the Atlas. He wore a celluloid collar and for a year afterwards was apparently well. On March 7, 1915, he began to complain of pain in the neck, difficult deglutition, anarthria and sphincter disturbance. On examination, the following were found: spastic tetraplegia, anesthesia over the superior thoracic region and anterior aspect of the neck, patellar tendon reflexes were exaggerated; cremastic and abdominal reflexes, absent; ankle clonus, Babinski and Oppenheim were exaggerated on both sides. Röntgen-ray examination of the cervical spine at this time showed



FIG. 6.—Röntgenogram taken seven months after the operation. Antero-posterior view. Note the disappearance of the fine lines of ossification. The left transverse process of the second lumbar vertebra is nearly gone.

marked atrophy of the first cervical vertebra with zone of rarefaction in irregular form. On March 31, 1915, the patient died from bulbar paralysis. Necropsy revealed giant cell tumor involving the first cervical vertebra.

ANSON (1928), reported two cases published under the title of "Osteitis Fibrosa Cystica of the Spine." The first case was a boy aged fourteen years, who was seen with paralysis of the lower extremities. Six months before admission, he started to have pain in the right side of the lower dorsal spine, followed 3-5 months later by difficulty in urinating, incontinence of the rectal sphincter, numbness over the legs and lower abdomen, complete paralysis of the lower extremities and loss of sensation below the umbilicus. The reflexes below the tenth dorsal segment were exaggerated, more so on the right than on the left. Röntgen-ray examination of the dorsal and lumbar spines revealed destruction of the right half of the tenth dorsal vertebra with circumscribed shadow between the tenth and eleventh ribs, suggestive of tumor. Exploratory laminectomy exposed an extradural mass which involved the laminae and transverse processes of the ninth and tenth dorsal vertebrae (right side), and part of the tenth rib on the same side. The diagnosis of a benign foreign-body giant cell tumor with hæmorrhagic cyst formation was made. A course of deep Coolidge-tube röntgen-ray treatment was subsequently carried out. Nearly two years and nine months



FIG. 7.—Seven months after the operation. Lateral view.

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later, the boy was able to work normally and the incontinence of urine and feces had totally disappeared.

The second case was a girl thirteen years old with a tumor in the back of the neck of three months' standing; there was associated pain but without paralysis. She gave a history of having twisted her neck five months before. On examination, there was a firm, rounded mass, slightly to the left of the median line opposite the second and third cervical vertebrae. Röntgenogram of the cervical spine showed a cyst-like tumor situated posteriorly apparently springing from the second and third cervical vertebrae. Laminectomy was done and a rounded mass was removed from the laminae of the second and third cervical vertebrae. Pathological study showed a friable, clot-like brownish material which contained foreign-body giant cells as well as cystic degeneration of old hemorrhagic material and granulation tissue. About five months later, the child was found perfectly well.

COTTON (1928), 1 case. This was a boy fifteen years old who had a fall on the buttocks.

Two months later, he began to have pain in the lower part of the back and left hip. Then again three months later, he had a wrench of the back. On examination, the back was found stiff and painful with a kyphus over the fourth and fifth lumbar and first portion of the sacrum; a fluctuating mass the size of a grapefruit to the left of the spine of the fourth and fifth lumbar vertebrae; flexion contracture of both hips;

paralysis of the anterior tibial muscle group; anesthesia along the distribution of the external popliteal nerve and loss of the left patellar tendon reflex. Röntgen-ray examination revealed bone destruction of the left side of the body, transverse process, lamina and pedicle of the fifth lumbar and left ala of the sacrum. No bone production. The clinical diagnosis of lumbo-sacral Pott's disease with lumbar abscess was made. Exploratory operation over the mass showed a cavity containing old blood, friable granulation tissue and loose pieces of bone. Histo-pathological examination of the tissue showed a benign giant cell tumor. General constitutional treatment with four series of Röntgen-ray therapy were given. Two years after the operation, the tumor disappeared, and the patient was able to walk with a cane. A slight decrease in sensation, however, remained over the outer surface of the left leg and dorsal aspect of the left foot. Röntgen-ray examination of the spine at this time revealed new bone production at the site of the lesion.



FIG. 8.—Röntgenogram taken a year after the operation. Antero-posterior view. Note the marked ossification at the left side of the first lumbar vertebra.



FIG. 9.—Lateral view.

Including the case herein reported, there are in all twenty-three cases of primary giant cell tumor of the vertebra found in the literature. The röntgenograms present characteristic circumscribed area of diminished density with

fine, fibrillary lines of ossification within the tumor. A secondary collapse of the vertebral body, as in this present case, however, has not been noted before. The above case emphasizes the importance of biopsy in establishing a diagnosis and demonstrates that where there is marked destruction and collapse of the vertebra, röntgenogram alone would not be of much diagnostic value in differentiating it from metastatic malignant lesion.

There are certain striking features of this condition which merit careful scrutiny and discussion. The lesion, occurring relatively more frequently at the lumbar spine than at the other portions of the spinal column, shows greater tendency to increase rapidly and heal more readily by ossification, spontaneously or following partial removal, when located at the cervical and lumbar spines. All the cases where the lumbar and cervical vertebræ formed the site of the lesion reveal extension through the vertebræ into the surrounding musculature with the consequent formation of palpable soft mass within a year of the onset of the symptoms. Subsequently an extensive ossification of the lesion generally occurs spontaneously or following an incomplete removal. In a way, this would indicate that they differ in some respects from the giant cell tumors occurring in long bones, which as a rule do not ossify, although ossification is also often noted following fracture (pathological) through the site of the lesion. This fact and the frequent occurrence of early and extensive ossification of giant cell tumors located in the lumbar and cervical vertebræ, which are undoubtedly the most mobile portions of the spinal column, is so striking and suggestive that one is tempted to resort to stress and strain as a probable cause of the enhanced ossification.

Urinary disturbance is one of the most distressing and persistent symptoms in these cases. In four of the six cases where this symptom was noted, the disturbance finally disappeared from one to three years after the partial removal of the lesion. One case, however, had persistence of the bladder and rectal disturbances nine and one-half years following an incomplete removal of the lesion. Death, probably from an ascending urinary infection, occurred in one case. On the whole, therefore, although the urinary disturbance has a tendency to hang on it ultimately disappears; and, whatever danger there may be of a subsequent grave ascending urinary infection is but slight.

#### CONCLUSIONS

1. Giant cell tumor of the vertebra may lead to destruction and collapse of the affected vertebra.
2. Biopsy is the only certain method in establishing a diagnosis.
3. Twenty-three cases of primary giant cell tumor of the vertebra are found in the literature.
4. Ossification of the lesion is early and extensive when the lumbar and cervical vertebræ form the site of the tumor.
5. The associated urinary disturbance ultimately disappears in most cases, although it may persist for a long period of time.

## GIANT CELL TUMOR OF THE SPINE

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# SARCOMA OF THE THYROID GLAND

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MALIGNANT disease of the thyroid gland is admittedly infrequent. Of this small group, the epithelial tumors predominate over those of mesoblastic origin. The thyroid anlage is an entodermal derivative, which shares, with the remainder of the alimentary tract and its allied organs, a rare disposition to sarcomatous development. The gross anatomic appearance, the age of incidence, and the clinical course of thyroid carcinoma and sarcoma are so similar that it is almost a clinical impossibility to differentiate preoperatively between them.

*Incidence of Thyroid Sarcoma.*—There is considerable disparity of opinion among authorities concerning the frequency of this disease. Kocher<sup>15</sup> stated that the thyroid gland is one of the chief seats of "acute" sarcoma. *Per contra*, Craver<sup>8</sup> says, "the occurrence of true sarcoma of the thyroid in man is doubtful." However, in nineteen of his histologically proven cases, seventeen were carcinomatous, one was round-cell sarcoma, another was small spindle-cell sarcoma. In 1902, Ehrhardt<sup>11</sup> was able to collect ninety-nine case reports of thyroid sarcoma together with 150 carcinomas of the same organ. This ratio does not exist in the papers of later authors. Herbst<sup>12</sup> reported that of 290 patients with malignant disease of the thyroid gland, seen at The Mayo Clinic between 1901-1921, nineteen had sarcoma. Simpson examined microscopically 1449 extirpated thyroids and found only fifty carcinomas and five sarcomas. Muller and Speese<sup>20</sup> collected the literature covering 117 cases of sarcoma of the thyroid; of these 30 per cent. were of the spindle-cell type, 23 per cent. were round-cell sarcomas and 17 per cent. were mixed-cell sarcoma. Speese and Brown<sup>25</sup> studied 426 lesions of the thyroid gland, among which carcinoma occurred nineteen times, and sarcoma three times. Bloodgood<sup>4</sup> found nine carcinomas and only one sarcoma in 148 thyroid lesions, surgically removed. Limacher<sup>17</sup> in Berne discovered forty-four sarcomas and thirty-eight carcinomas of the thyroid gland in 7641 autopsies. For his study of malignant disease of the thyroid gland, Louis B. Wilson,<sup>30</sup> in 1921, included European and American reports to total 991 malignant epithelial tumors and 195 sarcomas. The ratio of carcinoma to sarcoma is variously given as ten to one, or even four to one (Tebbutt and Woodhill).<sup>26</sup>

*Ætiological Factors.*—The greatest incidence of thyroid malignancy occurs in those particular geographic areas where endemic goitre is prevalent. This is an agreement with the general observation that malignant neoplasms have tendencies to develop in those tissues or glands which have been involved

in a preëxisting disease, in this instance—goitre. Chambers<sup>7</sup> believes it probable that in many instances a slow development of a primarily malignant goitre occurs, rather than the transformation of a previously benign goitre. Goitre may exist, however, for many years before sarcoma develops; twenty years in Becker's<sup>2</sup> case. Sarcoma and carcinoma are quite uncommon in non-goitrous thyroids, in my opinion. In Lartigau's<sup>16</sup> analysis of fifty-one cases of sarcoma of the thyroid, a history of preëxisting goitre was obtained in thirty-five instances. Chronic irritation produced by foci of degeneration in old colloid goitres may induce parenchymatous or stroma hyperplasia, occasionally resulting in carcinoma or sarcoma respectively. Carcinomatous and sarcomatous degeneration occur in the adenomatous types of goitres. At The Mayo Clinic, Herbst<sup>12</sup> did not observe one single instance of malignant neoplasm in 5867 specimens of exophthalmic goitre.

Other frequently mentioned etiologic factors are trauma and previous inflammation of the gland. Balfour has seen several cases of malignancy which developed subsequent to the injection of various irritants into large thyroids.

Both sexes are equally affected in sarcoma of the thyroid (Becker).<sup>2</sup> Of forty-nine case reports of thyroidal sarcoma which I have been able to cull from the literature, there were twenty-two males and twenty-seven females.<sup>1, 2, 3, 5, 10, 20, 26, 27, 29, 30, 32</sup> In benign goitre, the females frequently outnumbered the males in proportions of seven to one or even ten to one, but this difference in sexual incidence does not obtain for carcinomas and sarcomas of the thyroid. The reason for this disparity is not yet apparent.

Most sarcomas of the thyroid occur in the fifth and sixth decades of life. In this review, I found the average age to be fifty-three years. One unusual and striking difference of thyroid sarcomas from those sarcomas occurring in other body regions, is the uniformly late age at which the former appear.

*The signs and symptoms of malignant disease of the thyroid gland.*—Sarcomas and carcinomas of the thyroid are not commonly diagnosed correctly, while they are in the operable stage of the disease. The difficulty of correct diagnosis exists until the capsule of the gland is perforated by the growth. It is almost a clinical impossibility to distinguish between carcinoma and sarcoma of the thyroid. The rate of growth and approach of death are much more rapid, however, in sarcomas than in carcinomas, but this is a weak criterion for clinical differentiation.

The clinician must attempt to differentiate malignancy of the thyroid gland from benign adenomas of the thyroid with different forms of degeneration, from tuberculosis of the thyroid and from sudden hæmorrhage into a cystic cavity of the thyroid. Acute strumitis is usually generalized, whereas sarcoma is confined locally to one part of the gland, but it must not be forgotten that malignancy and infection may coexist. The occurrence of branchiogenic cysts and cysts of the cervical sinus along the anterior border of the sternomastoid muscle and the similar location of aberrant thyroid malignancies should be remembered.



The local manifestations of cancer of the thyroid usually precede any symptoms of altered thyroid function. The first notable sign is some change in the physical characteristics of the primary benign goitre, particularly when such a goitre becomes hard, bossy, nodular and irregular. Suspicion is immediately aroused by the rapid and steady increase in size of a previously quiescent goitre in a patient over forty years of age.

The presence of outlying hard palpable lymph nodes is suggestive and for diagnostic confirmation one of such nodes may be removed and examined histologically. This procedure aids in determining the treatment to be employed; if the tumor is inoperable, the histological picture of the nodal metastases determines the expectation of response to irradiation.

Enlargement of subcutaneous veins over the tumor is a late finding and is not of frequent occurrence. Fixation of the tumor to the skin is more frequent in sarcoma than in carcinoma but, at the most, is a very late and uncommon phenomenon, as is ulceration. After the capsule of the thyroid has been perforated, decreased mobility of the gland soon occurs, so that the palpating fingers detect the fixity of the thyroid growth to the trachea and larynx, which often move with the tumor.

Although the major portion of the thyroid may be involved in the sarcomatous process during the terminal period of the disease, the symptoms of hypothyroidism are never in evidence. Tremor, palpitation, loss of weight, tachycardia, increased metabolic rate, in fact the Basedowian syndrome (exclusive of exophthalmos) may accompany a small percentage of sarcomas of the thyroid. Tillaux <sup>28</sup> found typical symptoms of exophthalmic goitre (except tachycardia) in a case of sarcoma of this gland. After removal of the sarcoma, the toxic symptoms disappeared, but the patient died later with metastases.

The appearance of neuralgic, radiating pains has been known to precede the local appearance of the tumor, but this is not the customary sequence. The pain radiates from the neck up the side of the head to the ear (N. occipitalis major), or down into the shoulder and arm. It is usually a unilateral pain. It is due to the manifestations of deep growth and pressure upon or involvement of deep cervical nerves.

Dyspnoea is a frequent symptom and is produced by sabre-sheath stenosis of the trachea. Lateral radiographs of the neck demonstrate very clearly this antero-posterior compression of the trachea and the chondro-malacia of the tracheal rings. The sarcoma may penetrate the trachea deep enough to produce bloody expectoration. The hoarseness which sometimes occurs is caused by vocal cord paralysis (laryngoplegia) from involvement of the recurrent laryngeal nerve in the tracheo-oesophageal sulcus. In such an event, laryngoscopic examination is important because benign goitres do not frequently produce paralysis of the vocal cords. The brassy or "goose" cough which accompanies many aneurysms of the aortic arch, occasionally is a symptom of malignant disease of the thyroid.

If the growth begins on the posterior aspect of the thyroid, a dysphagia

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frequently develops, which is due to direct attachment to the œsophagus rather than pressure alone. Dysphagia is an uncommon symptom of benign goitres, even in the substernal type.

Pressure of the tumor growth upon the cervical sympathetic nerves, or infiltration of the sarcoma in the region of the carotid sheath may produce paralytic miosis, loss of the pupillary reflex, unilateral facial hyperæmia and sweating, enophthalmos and narrowing of the palpebral aperture.

Fever, as high as 102.5 F., has been known to precede the appearance of the sarcoma. Fever is far more common with sarcoma than with carcinoma of the thyroid.

*Classification of Sarcomas of the Thyroid.*—1. Spindle-cell sarcoma, of which the fibro-sarcoma is a desmoplastic type. The most common variety of sarcoma of the thyroid gland.

2. Round-cell sarcoma, including a type that resembles the malignant lymphocytoma.

3. Mixed-cell sarcoma, of which the so-called giant-cell sarcoma is a sub-group.

4. Carcino-sarcoma. (Epitheliosarcomes.)

*Gross Pathologic Anatomy.*—Why does malignant disease of the thyroid more commonly involve the right side? This may be mere coincidence. Most sarcomas of the thyroid develop deep in the substance of the gland and not at the surface. Encapsulation of the tumor enhances the prognosis at least 100 per cent.

Eventually the sarcoma pierces the capsule of the thyroid and infiltrates the trachea and the great vessels of the neck. Later it may extend sub-sternally to infiltrate or ensheath the aorta and its branches as well as the apex of the lungs.

Usually fibro-sarcoma is of harder consistency than the round-cell sarcoma. When its lobulated substance is sectioned, the cut surface is yellowish or grayish-white, but it may be reddish-brown in color if there are hæmorrhagic areas in its compages, or if the blood supply is well developed. Lymph nodes involved by metastases are hard and yellow on cross-section.

*Microscopical Pathology.*—The cells of a rapidly growing thyroid carcinoma may assume, sometimes, the shape of anaplastic undifferentiated cells, even to the degree of appearing spindle-shaped, in which event the tumor is incorrectly termed sarcoma. The differential diagnosis between scirrhus carcinoma and fibro-sarcoma of the thyroid is particularly difficult. Proof of the fibro-blastic origin of the tumor cells can be obtained by staining with phospho-tungstic acid-hematoxylin, if delicate fibrils are shown terminating each tumor cell.

Fibro-sarcoma, with which I am especially concerned in this article, is histologically less malignant than the other varieties of sarcoma. The large fusiform or spindle cells are usually arranged obscurely in interlacing bundles without definite architecture. The nuclei are frequently large, irregular, deep-staining and contain heavy chromatin filaments. The spindle cells in-

volve the interacinous connective tissue and trabeculæ of the glands. The thyroid vesicles or acini are surrounded by this tissue growth, which rarely intrudes into the lumina. The parenchymal cells of the acini are squeezed within the new tumor tissue and eventually undergo pressure atrophy and replacement by neoplastic cells. A small portion of these so-called fibro-sarcomas may have a neurogenic origin, although this is difficult to prove without necropsy evidence of visceral neurofibromatosis.

Histogenetically the mixed-cell sarcoma of the thyroid may be identical with the spindle-cell type. Microscopically it is characterized by the presence of large, polyhedral cells, which tend to be clumped in certain areas. The nuclei are large, irregularly shaped, frequently budding and have a heavy chromatin content. Langhans cells and cells approaching the myelopax type may be scattered throughout these tumors. Are these giant cells the ordinary foreign-body types of giant cells or are they derived from endothelial cells in the parietes of the blood vessels? Probably the latter hypothesis is correct as these giant multinucleated cells seem to line vascular channels having no other endothelium.

Concerning the carcino-sarcomas, L. B. Wilson<sup>30</sup> has this to say: "Beside their connective tissue elements in which any form of sarcoma cell may be the dominant one, although it is most frequently the spindle-cell type, there are also almost invariably present large or small groups of parenchymatous cells which show that they are also proliferating. Whether or not the neoplastic process started with the parenchymal elements which were later destroyed by a secondary proliferation of the connective tissue elements, or whether the process from the beginning was a proliferation of the connective tissue elements with only secondary stimulation of the parenchymatous cells as they are gradually squeezed out, it is impossible to say." Masson<sup>18</sup> recognizes a tumor called epitheliosarcome, which in the beginning is a thyroid carcinoma, but the stroma of which acquires sarcomatous properties and progressively outgrows the epithelial elements. This is not inconsistent with similar neoplastic occurrences, such as the occasional association of sarcoma of the uterus with corporeal adeno-carcinoma and the coexistence of sarcoma and adeno-fibroma of the mammary gland.

*Metastases.*—Binnie<sup>3</sup> reported a primary sarcoma of the thyroid with metastases to the humerus and to the small intestine. Morf reported two instances of metastases to the gastro-intestinal tract among a series of forty collected cases of sarcoma of the thyroid. Kobler<sup>14</sup> studied a spindle-cell sarcoma of the right thyroid lobe, which metastasized to liver, right kidney, and upper ileum. Pick<sup>22</sup> observed metastases in lungs, heart, liver, stomach, intestine, pancreas, dura mater and palate from a spindle-cell sarcoma of the thyroid. Becker<sup>2</sup> reported a giant-cell sarcoma of the thyroid which metastasized to lungs, pleura, and bronchial lymph glands. Muller and Speese<sup>20</sup> observed metastasis to the liver from a fibro-sarcoma of the thyroid. It seems that sarcoma of the thyroid gland metastasizes chiefly to lungs, liver, bone, kidneys and gastro-intestinal tract.

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In some cases secondary tumors appear before patients and surgeons alike are aware of the tiny primary sites in the thyroid gland. For this reason, these have been termed the "latent" type. Sarcoma of the thyroid metastasizes more commonly by the blood vascular system, due to growth invasion into the thyroid veins. Only at a later stage of the disease, are the lymphatic pathways implicated in the dissemination of sarcoma cells. In primary sarcoma of a lateral lobe of the thyroid, especially of its outer and posterior portion, the lymph node metastases first occur along the internal jugular vein. When the primary disease is situated in the isthmus or in the anterior and internal part of a lateral lobe, the lymph glands in the mediastinum are first affected. Occasionally, such an enlarged lymph gland can be palpated within the supersternal space of Burns.

*Irradiation Treatment of Thyroid Sarcoma.*—Perthes<sup>21</sup> believes that sarcoma of the thyroid is as favorable for this form of treatment as sarcoma of the lymph nodes or of the tonsils. On the contrary, it has been Schädel's experience that sarcoma of the thyroid, whether of the spindle-cell, polymorphous-cell or lymphoid-cell type, does not react well to irradiation. Schädel<sup>23</sup> does state, however, that the primary sarcomatous lesions respond more readily to X-ray or radium therapy, than the secondary or metastatic tumors. The radio-sensitivity of thyroid neoplasms increases in the following order of ascendancy: fibro-sarcoma < carcinoma < mixed-cell sarcoma < round-cell sarcoma.

The relative radio resistance of fibro-sarcoma is due to its fibrous character. It is for this reason that radium therapy is preferred to X-irradiation, because the former exerts a strong action directly on the tumor cells, whereas the latter injures indirectly to some extent by vascular and connective tissue changes. Moreover, if the growth is well localized in the thyroid, radium is preferable to X-ray because the latter method tends to injure the remaining normal thyroid tissue. Parathyroid tetany has followed heavy generalized irradiation of the thyroid region.

The metastases in the later stages of the disease are not controlled well by irradiation. For such cases, X-ray therapy is a more suitable palliative measure. Irradiation for thyroid sarcomas may be (a) post-operative (prophylactic), (b) pre-operative, (c) complete treatment for inoperable cases (palliative).

Interstitial radium therapy can be applied in several ways. A post-operative drainage tube inserted in the wound bed may contain radium capsules *in tandem* to give about 650 millicurie hours (Bowing).<sup>5</sup> After surgical exposure of the tumor mass, steel needles containing radium salt or emanation may be placed in parallel arrangement throughout the lesion. The filter in such a case is the equivalent of 0.5 millimetre of silver. Radon implants in the form of gold or platinum "seeds," with filtration of 0.3 millimetre, can be inserted into the tumor by means of hollow needles and stylet.

External irradiation by means of a radium pack or moulage applicator or

by X-ray can be given to the limit of skin tolerance. In post-operative cases, such treatment should be withheld until the incision is healed.

*The Surgical Treatment of Thyroid Sarcoma.*—The cures reported for sarcoma of the thyroid occurred in those instances where the discovery of sarcoma was made by pathological examination after an operation for presumably benign goitre. This represents malignancy in a preclinical stage and naturally is the only type which affords a happy prospect of cure. Still other sarcomas slightly more advanced in degree, are only identified and recognized as such when the surgeon attempts to remove them.

A radical operation for palpable, extensive and clinically malignant tumors of the thyroid gland is impossible, because the entire thyroid gland with the parathyroid bodies cannot be completely removed. However, surgical treatment, palliative in nature, such as tracheotomy and lobectomy are justified, as such measures *tend in certain cases to prevent or delay death by the local effects of the tumor.* Block dissection of the lymph glands of the neck is not as important a procedure in sarcoma as in carcinoma of the thyroid, but this cannot always be foretold even with the help of frozen section biopsical diagnosis, in the event that a one-stage operation is planned.

The best incision for exposure is the usual semi-lunar one. This permits the insertion of a tracheotomy tube also, if this is necessary. If the tumor is definitely unilateral, some surgeons occasionally make an incision along the anterior border of the sternomastoid muscle. One entire lobe and half the isthmus (all within an intact capsule) are removed. No attempt should be made to enucleate the malignant tumor. The surgeon must be particularly cautious about ligation of the veins because of the danger of sarcoma-cell embolic metastasis.

*Results.*—Patients with sarcoma of the thyroid proceed to a more rapid lethal termination than do those with carcinoma of the same gland. The usual expectancy is two or three years after the inception of the disease. Herbst<sup>12</sup> makes the following comment: "The mortality, then, is practically 100 per cent. It seems that sarcoma of the thyroid proceeds to a fatal end about as rapidly as any malignant condition known." A. Kocher<sup>15</sup> states that sarcoma of the thyroid recurs in 100 per cent. of all cases subjected to operative removal. Wilson<sup>30</sup> gives six months as the average post-operative length of life for sarcoma of the thyroid gland. This disease, then, is almost invariably fatal and the cures by surgery alone are fortunately accidental rather than consciously intentional.

CASE REPORT.—H. D., a male, aged 56 years, applied for diagnosis and treatment on August 14, 1928.

*Family History.*—The patient was one of thirteen children. All of these were in good health with the exception of the patient and one sister who died of some obscure disease. There was no history of cancer in the immediate family. His mother died of senility, but had a life-long adenomatous benign goitre. His daughter has a slight enlargement of the thyroid gland.

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*Previous History.*—Since youth, his thyroid was noticeably and palpably enlarged. No treatment was given because this goitre caused no toxic or local pressure symptoms.

*Chief Complaint.*—Aphonia and increased growth of thyroid gland.

*Present Illness.*—One week ago the patient suffered a complete loss of voice. During the past year his neck had undergone gradual enlargement. There were no loss of weight, no pain and no other symptoms. His appetite and ability to sleep were unimpaired.

*Physical Examination.*—The patient was a well-nourished male of late middle age. His neck measured  $44\frac{1}{2}$  centimetres in circumference at the centre. At the base of the neck the circumference was 46 centimetres. The thyroid was palpably enlarged and nodular in character, particularly the right lobe. (Fig. 1.) There was no evidence of hyperthyroidism; no tremor; no ocular signs.

*Laryngeal Examination.*—There was a complete loss of motion of all of the structures on the right side of the larynx, indicating a paralysis of the right recurrent laryngeal nerve. The lumen of the larynx is not visibly encroached upon by infiltration of the thyroid tumor, but the glottic space is somewhat decreased by the paralysis of the vocal cord.

*Primary Irradiation.*—From August 16, 1928, to August 30, 1928, eight X-ray treatments were given over the neck in areas marked A, B and C. The usual factors were 180 kilovolts, 4 milliamperes, 40 centimetres anticathode-skin distance, 0.5 millimetre of copper filtration, 45 to 60 minutes exposure and fields of  $10 \times 16$  centimetres.

August 28, 1928. The thyroid gland was irradiated by the use of a radium "pack." (External radium therapy at a distance.) The focal distance was five centimetres; the filtration was two millimetres of brass and the dosage 18,837 milligram hours.

By August 31, 1928, the thyroid tumor had diminished somewhat. The circumference of the centre of the neck was now  $42\frac{1}{4}$  centimetres, and the base of the neck 44 centimetres.

*Operation.*—September 13, 1928. A partial thyroidectomy was done. Because of the mobility of the thyroid tumor, it was believed that it could be extirpated completely by surgery. Some apparently normal thyroid tissue remained. In the course of the operation, the growth was found to be irremovably adherent to the larynx, so that necessarily some of the tumor tissue was left behind.

*Pathological Report.*—September 13, 1928. The specimen consisted of a large lobulated mass measuring  $7 \times 7 \times 4.45$  centimetres in thickness. No definite capsule could be made out although in one or two small areas on the surface a thin capsule-like tissue could be stripped off, however, tearing easily and showing firm adherence to the under-



FIG. 1.—Pre-operative film of chest on June 26, 1928, prior to treatments. No definite sign of lung involvement.

lying tissue. The mass was irregularly nodular. On section, the cut tissue was yellowish white. At one pole was a partially circumscribed ovoid mass 3.5 centimetres in diameter showing an almost stony hard consistency. Fresh sections showed an apparently striated whitish tissue with numerous translucent areas and many yellowish foci, some of which gritted on cutting. The remaining tissue of the mass surrounding the nodule described was of similar appearance but of a softer consistency. There was no evidence of thyroid tissue in this mass. The cut tissue on handling exuded a small amount of translucent glairy fluid. Attached to the mass was a small lobule,  $2 \times 1 \times 1$  centimetres, of pinkish thyroid tissue which appeared continuous with the underlying whitish tissue described above and which showed small irregular strands infiltrating the tissue.



FIG. 2.—Post-operative film of chest on November 9, 1928, showing lung metastases, displacement of trachea with soft tissue swelling anterior to it.

There was a small circumscribed discrete, apparently secondary nodule of firm white tissue. The third and fourth pieces of tissue were small in size and similar to the tissue described in the primary mass.

Tissue for frozen section examination was taken from the large nodular adenoma-like mass described above and from the remainder of the primary mass near the opposite pole. Both of these sections presented essentially an identical histological picture. The predominating tissue was a completely non-cellular, coarsely fibrillar or collagenous tissue. At one edge of the section was a similar coarsely fibrillar tissue studded with many hypertrophic and hyperchromatic polymorphous nuclei, the predominating form being fusi-

form. An occasional mitotic cell was seen in every two or three microscopic fields. Some of the nuclei showed pyknosis. The fibrils ran in every direction forming many interstitial spaces, some of which showed a pale greenish blue stain (mucin-reaction). There was no demarcation between the non-cellular and cellular tissue, the latter, in fact, being continuous with the non-cellular tissue and showing a diminishing extension of nucleated fibrils from the cellular into the non-cellular area.

Sections for paraffin preparation included six representative areas covering the entire specimen. Most of these sections showed a coarsely fibrillar and collagenous compact nucleated tissue which appeared uniform, solid throughout. The nuclei of this tissue showed extreme variation in size and shape, some being hyperchromatic, others vesicular and many of the nuclei showing pyknotic changes. There was a considerable number of multinucleated cells. From many of the nuclei coarse eosinophilic fibrils could be seen extending from the poles of the nucleus, in some instances being tripolar. This tissue in some sections showed very marked mitotic activity and multiple scattered discrete areas of loose, areolar, nucleated, finely fibrillar tissue suggesting mucin secretion. There were also multiple scattered discrete areas of non-nucleated fibrillar tissue suggesting necrobiotic changes. Section of the growth in the region of the

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thyroid tissue described above exhibited an occasional small intact thyroid acinus, some showing colloid secretion and embedded in the fibrillar tissue. The separate small nodule described in the gross consisted of similar highly nucleated compact fibrillar tissue with multiple areas of mucin secretion (so-called "myxomatoid" changes). Variations in the size and shape of the nuclei in this section as well as in one or two other sections were most extraordinary. The vascularity of the predominating fibrillar tissue was slight. No definite thrombosis could be determined, nor was there any definite evidence of calcification.

The pathologic diagnosis was fibro-sarcoma of the thyroid, involving a complete lobe with increase in growth to about twice the normal size of the lobe and showing secondary mucinous, necrobiotic and autolytic degenerative changes. The growth appears to be actively invasive.

*Report of Microscopic Examination by Dr. Joseph Colt Bloodgood.*—Histologically, the very remarkable feature was the very large amount of eosin-staining stroma in the mesh work of which were single cells and now and then two or three cells but no large nests. In many places there were cavities without cells. More of these cells were forming colloid vesicles or colloid material. The morphology of the cell varied, spindle and stellate cells predominating. Whether this was the true nature of the tumor or a change from radiation it is impossible to say. I am of the opinion that it was an old fibroma which had become a fibro-sarcoma, and there was some destruction of the cells due to radiation. Entire colloid vesicles were surrounded by tumor. It was more of the tumor infiltrating thyroid than of thyroid tumor. These are slow-growing tumors.

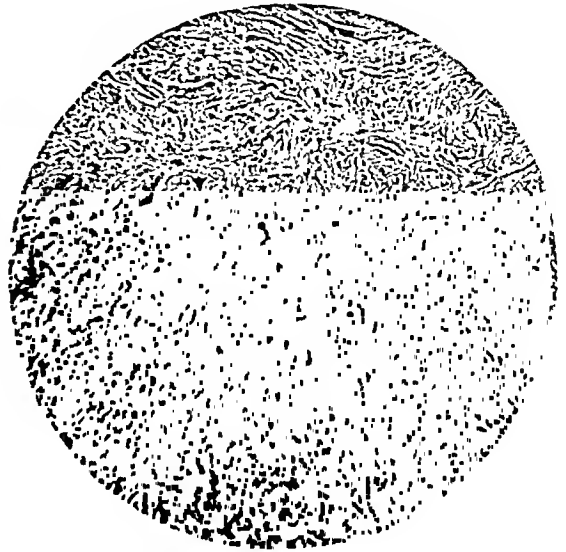


FIG. 3.—Low power photomicrograph of fibrosarcoma of the thyroid. Note interlacing bundles and architectural confusion.

*Course of the Disease.*—September 13, 1928.—Loss of twenty pounds in weight.

September 24, 1928.—Chest röntgenogram was negative for metastases.

October 23, 1928.—Hæmoglobin was 75 per cent. Because of this and general debility, a blood transfusion was given of 1000 cubic centimetres.

November 11, 1928.—Another blood transfusion (1000 cubic centimetres) was given. There were two short periods of hæmoptysis, presumably due to perforation of the trachea and larynx by the malignant growth. Intermittent radiating pains occurred in neck and chest. Coley's mixed toxin had been given intramuscularly (Miii); followed by acute chill and rise of temperature to 103 F. The hæmoglobin percentage was now 80 per cent.

November 9, 1928.—Coley's toxin (Miii) intramuscularly caused a chill and fever of 103 F. Consultation with Drs. W. B. Coley and Lloyd F. Craver, whose joint opinions were that the prognosis was hopeless. By this time, there were obviously pulmonary metastases. Continued palliative irradiation and inoculation of Coley's toxin were the measures decided upon for subsequent treatment.

November 24, 1928.—Hæmoptysis. The hæmoglobin was still 75 per cent.

November 25, 1928.—Continued expectoration of blood and marked asthenia now predominated the clinical picture. There was obvious recurrence of the malignant tumor at the primary site. Another transfusion of 1000 cubic centimetres of blood was given for palliation.

December 1, 1928.—Coley's toxin again started, commencing with 3M, and each day



increasing the dose by one minim. On December 3, 1928, the patient's temperature was 100.4 F. without toxin. There was continual loss of weight and strength.

December 5, 1928.—The patient now complained of severe pain in the lumbar region, radiating along the spinal column. The hæmoglobin was now 68 per cent.

December 9, 1928.—A rapidly growing recurrent radio-resistant tumor mass now appeared on the right side of his neck. Another blood transfusion of 1000 cubic centimetres was given, but the patient continued weak and complained of severe pain. The laryngo-tracheal infiltration of the sarcoma was now sufficient to cause severe dyspnoea.

December 17, 1928.—He now vomited dark brown fluid and expectorated bright red sputum.

December 20, 1928.—The liver was grossly enlarged; it extended into his pelvis. The pain in neck and back became excruciating.

December 26, 1928.—Hæmaturia was now apparent. At this stage, there were



FIG. 4.—High power photomicrograph of fibrosarcoma of thyroid. Illustrating the predominant fusiform cell.



FIG. 5.—Invasion of thyroid substance by the fibrosarcoma with resultant displacement and pressure atrophy of the thyroid acini.

obviously metastases of the lungs, bones, liver, kidneys gastro-intestinal tract and cervical lymph nodes.

December 28, 1928.—*Exitus lethalis*. Death occurred sixteen months after the onset of recognizable signs of increased growth of the goitre, and three and one half months after operation. Necropsy was refused.

*Post-Operative Irradiation*.—With the high-voltage X-ray he was given the following number of treatments over each area (period September 26, 1928, to November 28, 1928) A-1, B-1, C-12, D-5, E-6, H-3, M-3, N-3.

With external radium therapy the following applications were given, on October 22, 1928: (a) To neck anteriorly, one centimetre distant, two millimetres of brass filtration, 3,120 milligram hours. (b) To left chest anteriorly at 1 centimetre distance, same filter, 3,650 milligram hours. (c) To left chest anteriorly at two centimetres distance, same filter, 7,440 milligram hours.

#### SUMMARY

Fibro-sarcoma of the thyroid gland is a rare and fatal disease. The initial response to irradiation may be favorable, but the sarcoma rapidly metastasizes by the blood vascular system to thoracic and abdominal viscera. A typical case of this malady is herein reported.

We have recorded seventeen cases of sarcoma; seven in males and ten in

females ranging in age from twenty-five to sixty-one years. Duration of nodule or irregular enlargement of the thyroid from one month to twenty-five years. In all cases from one to eight months there was a rapid increase in size, or change in swelling of the neck. Duration of life following incomplete operation ranged from a few hours to one year, with the exception of one case which has just been operated on for the relief of tracheal pressure. Sarcoma represent about .6 per cent of all cases.

Diagnosis made were mixed-, round- and spindle-cell sarcoma, lympho-sarcoma and round-cell sarcoma, with the greatest number of mixed cells. Metastases to axilla, lungs, bronchial glands, liver, trachea and œsophagus, and one especially interesting case in which we had tumor of the thyroid, tumor of the breast of the same character, with the extension to the œsophagus and trachea, with metastases at no other place. Radium and X-ray were used in several cases and seemed to hold growth in check for a time.

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# EXTRAPLEURAL THORACOPLASTY DURING THE TREATMENT OF PULMONARY TUBERCULOSIS\*

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DURING the past decade a voluminous literature has accumulated in regard to the treatment of pulmonary tuberculosis by thoracoplastic collapse of the lung. A number of different opinions have been expressed and minor controversies have arisen concerning technical details of the procedure, but the testimony is unanimous—among surgeons at least—that the operation is beneficial in wisely selected cases. Many of us have crystallized our ideas sufficiently to warrant this presentation to a group of general surgeons such as comprise the membership of this society. It is not our purpose or intention to discuss at length the merits of the various controversies but simply to offer our conclusions, based as they are on a long, and at times a bitter, experience. There are phases of the subject on which we cannot dogmatize, because we are in doubt as to their solution.

During the ten years much has been learned, and by means of a constant follow-up system and from a searching consideration of the causes for our failures we have reached some definite conclusions which we hope to elucidate.

We have been closely associated in this work with Dr. James Alexander Miller and his assistants, and have leaned heavily upon them, not only for pre-operative advice in the selection of cases and for their post-operative care, but also for instruction in the principles of the modern treatment of tuberculosis, and much of the knowledge we possess is due largely to them. We wish here not only to acknowledge this debt and to express our appreciation but also to emphasize to every surgeon who may contemplate the care of the tubercular patient the necessity of becoming associated with some one who is familiar with and interested in the details of the treatment of pulmonary tuberculosis, and who from his knowledge can form a reliable judgment in respect to the prognosis and ultimate fate of any particular patient. The importance of this has been repeatedly stressed by most workers in this field. In this connection we wish to disabuse the minds of those who, unfamiliar with the subject, may consider that these operations are per se curative measures. They are not. Quite the contrary, they should be looked upon only as incidents, often important in the course of treatment of the pathological processes, which simply alter the local conditions, whereby the balance is changed in favor of the patient in his fight against the disease. His resistance, which under the former conditions was unable to combat the

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\* Read before the New York Surgical Society, November 13, 1929.

disease successfully, can under the new and changed circumstances overcome and heal or arrest the tubercular lesion. We do not remove the diseased tissue. He is still suffering from tuberculosis and must undergo a more or less prolonged course of treatment to effect a cure.

All these operations place an added burden on an already sick person, and therefore in contemplating an operation in any case, we must consider two factors: Can the patient withstand the immediate shock of the operation, and will the procedure so influence the lesion that it will be able to heal?

The operations we have under consideration are first, the thoracoplastic collapse of the lung by means of the subperiosteal, and therefore the extrapleural, removal of the posterior portions of the ribs from and including the first to the tenth or eleventh; and second, the division of, or removal of a portion of, the phrenic nerve, where it lies on the scalenus anticus muscle in the neck. We shall consider this latter only in connection with cases in which rib resection has been already performed, or in which such an operation is contemplated. The consideration of its value as an independent procedure would lead us too far afield in this paper.

We are in complete agreement with those writers who believe that the thoracoplastic operation should be done in two or more stages, and that it is hazardous to remove all the ribs at one stage. We attempted the latter during our early experience with discouraging results. There was a 25 per cent. operative mortality within the first two weeks post-operative, and 14 per cent. late mortality. It was simply a question of too much operation. Even in some of the cases in which the procedure was divided into two stages we have had the same result. It is always a temptation to continue an operation if the condition of the patient at the time is reported excellent, but in these cases it is better to err on the safe side as otherwise the results may prove disastrous. The cause of death in such cases has been variously attributed to "shock," "mediastinal shift," or "flapping of the mediastinum."

It is still a matter of opinion whether the upper or the lower ribs should be removed first. We feel we can secure a greater degree of collapse by removing the upper ribs first, believing that we cannot obtain the full benefit from the fall of the ribs until the first rib has been taken out. It is an academic question, if the second stage can follow the first before the resected portions have begun to regenerate, which is usually well established within a month or six weeks. This question takes on an added significance if the second stage must be deferred for several months, because by this time the resected portion of the chest wall (which in the upper limits is held out by the curve of the ribs above it) has become so stiffened and fixed that the fullest degree of collapse is not obtained after the second stage.

It has been maintained recently (especially by some French writers) that equally good results may be attained by the removal of the posterior axillary portion of the ribs as by the removal of their extreme posterior portions. We are firmly convinced that this is erroneous. We feel sure that the lack of success in certain cases is due to this failure to remove the extreme

posterior ends of the ribs, especially in cases with large cavities. We unreservedly advocate dividing the ribs as close as possible to their attachment to the transverse process of the vertebræ; because only in this way can we obtain the complete collapse of that portion of the lung which is situated in the gutter bounded mesially by the bodies of the vertebræ, and posteriorly by the vertebral transverse processes and the acutely arched ribs. In this connection it is important to bear in mind that it is much easier and less hazardous to carry out the proper procedure at the first operation (when the tissues are comparatively normal and the rib removal is relatively simple) than it is to attempt a revision of a case after the new bone has formed with various boney plates, and the pleural attachments have become thickened, extremely vascular and densely fibrous. We have attempted a revision in five cases, two of them being our own early ones. Of these five two died, one from pneumonia and one as the result of hæmorrhage and infection. In all of them the operation was difficult and prolonged and the bleeding was profuse.

We usually remove from ten to twelve centimetres of the lower ribs and a gradually diminishing amount as we proceed upward. From one to two centimetres are removed from the first rib.

As these wounds are of wide extent, and a dead space necessarily remains beneath the large flap, a careful hæmostasis should be carried out, and every vessel which may require a hæmostat should be ligated. We drain the dead space beneath the flap with the empty cover of a cigarette drain, which is removed at the first dressing on the third or fourth day post-operative.

In our earlier cases we divided the phrenic nerve only when a cough persisted, with or without positive sputum, after a complete thoracoplastic collapse had been accomplished. Of late we have divided the phrenic as a preliminary step to the procedure and have come to believe that this is the proper sequence. A more gradual collapse of the lung can thus be obtained and we can gain valuable information as to whether the patient will be benefited by a more extensive collapse. The operation is a simple one, performed under local anæsthesia, and often will alter the local conditions sufficiently to allow the patient to combat his disease so successfully as to render him a far better operative risk. In certain cases the improvement has been so striking that we have refrained from further operations, but as these cases are still under observation we are unable to report on the final outcome, and have not crystallized our opinions sufficiently to reach a conclusion as to its permanent value.

Our series of cases shows that the condition of the contralateral lung is of vital importance and that it is difficult in the extreme to form a correct estimate of the significance of the X-ray evidence of former disease.

Of the twenty-four operative deaths in the series, sixteen were in bilateral lesions and seven of these were due to an immediate spread or reactivation of the disease in the contralateral lung, while there was only one such case among the eight operative deaths in the unilateral group.

We think that an important factor in promoting this reactivation of what was often considered a quiescent or healed lesion is due to a tuberculin reaction. The release in the circulation of a certain amount of tuberculin from the manipulation and sudden collapse of an extensive lesion is frequently the cause of a sharp, sudden post-operative rise in temperature. Any case with distinct evidence of disease on the opposite side has a poor prognosis whether the lesion seems to be quiescent or not.

We have taken as a criterion of whether a case is active or quiescent the sole symptom of fever, and have disregarded in this connection any slight hæmoptysis or streaking. It is difficult and often impossible to estimate the importance of a slight hæmoptysis. It is certainly always a danger signal and a distressing symptom to a patient. There are many cases in which it is the only symptom of activity (if it is a sign of activity) and it may occur unaccompanied by fever or other signs of toxæmia. Each case must be considered by itself. From the standpoint of operation alone it does not appear to present any added risk.

The choice of an anæsthetic is of great importance. We have employed nitrous oxide and oxygen, ethylene and oxygen, local anæsthesia, and spinal anæsthesia with spinocaine. These each have advantages and disadvantages in this type of case. Certain patients are so nervous and apprehensive that a general anæsthetic is less of a strain than is a local one. Nitrous oxide if well borne is an excellent anæsthetic but there are patients who take it badly, have a pronounced cyanosis accompanied by marked inspiratory dyspnœa, which places a great burden on the right side of the heart. Many of these patients have been leading a sedentary life; their heart muscle has lost much of its normal tone, and is flabby. This burden on the heart may result in a dilatation with serious consequences.

We have noted no ill effects from ethylene. It does not cause cyanosis, is non-irritant and has no bad late affects. However the danger of explosion during its use has been stressed and advertised to such an extent, and its use has been forbidden in so many hospitals, that we have not been allowed to use it as generally as we would wish.

In view of these conditions we employ local anæsthesia as much as possible, but from time to time meet with cases in which the pleura is so firmly adherent to the ribs that a complete anæsthesia cannot be obtained and we have had to supplement it with nitrous oxide and oxygen.

Because of the glowing reports of spinal anæsthesia we were persuaded to try it, and have to report a death from its use. In confidential conversation with several men who have had experience with it in other conditions we find that this is not a unique case though we have failed to find many of them reported in the literature.

This class of patients withstands a pyogenic wound infection extremely badly and yet undergoes the ordinary operative procedure astonishingly well. As their wounds are extensive the infection is apt to be severe. In our series we feel that three cases of death are directly due to this cause and that in

## THORACOPLASTY DURING TREATMENT OF TUBERCULOSIS

three others the fatal spread to the opposite side was directly dependent on it, because it lowered the resistance of the patient to his disease.

In this day and generation it may seem strange for anyone to try to establish an alibi for a post-operative infection when we all know that careful technic and prophylaxis is the answer, but we would like to stress certain important elements which we think have determined in a measure the high mortality in this series of cases. Most of these cases have been cared for in hospitals where the immediate post-operative care has not been as intensive as in some other institutions in which the personnel has been larger, and we feel that some of the infections have occurred from displaced and disordered dressings, especially because we have had no serious complication of this nature in private work. The same applies to other complications which have proved fatal. We must remember that the act of coughing is a difficult and painful process following one of these operations, and a nurse who is in constant attendance can often do much to aid the patient in accomplishing this important act. Its importance will be patent to everyone if he will but remember that there is often a large amount of thick, tenacious sputum suddenly emptied into the bronchial tree from the collapsed cavities of the tubercular lung, and that this must be removed by coughing.

Five of our cases died as a direct result of this condition; one seemed to be virtually inundated by this secretion, and four others from a massive collapse. We have had six cases in all of massive collapse; four times in the contralateral lung and twice in the lower lobe after resection of the upper ribs of the same side. This complication has not apparently been noted by others,\* and we feel it may have been confused with what was considered a shift of a movable mediastinum. The two conditions have many physical signs in common—displacement of the heart, diminished or absence of breath sounds over the lower lobe, rapid, thready pulse, marked dyspnoea and cyanosis. An X-ray will readily distinguish between the two conditions as the atelectatic lung throws an opaque shadow. We have attempted to prevent its occurrence by having the patient lie on the operated side and by encouraging coughing. This complication has occurred as early as a few hours after operation and as late as the third day. It is a serious development and careful nursing is an invaluable aid both in its prevention and treatment. We have not employed bronchoscopy for its relief.

One of our cases died during operation when on wounding the thin pleura (which resulted in a partial pneumothorax over a very limited area), the patient's heart suddenly stopped beating and all efforts at resuscitation failed. This accident resembles those occurring on the induction or during a refill of a pneumothorax. In all our experience we have had two similar deaths on introducing a needle into a nontuberculous lung abscess through an open wound of the chest wall preparatory to drainage. Being ignorant of the exact cause of death in these cases we speak of it as "pleural shock,"

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\* Berry, F. B., *Archives of Surgery*, vol. xviii, p. 257, 1929.



a term which has many objections but which at least has this advantage: It does not assume a definite pathology. Some have attributed it to air emboli. This may be the correct etiology.

In this series there have been a number of cases which today we would consider bad risks, and others poor risks, and we would refuse to operate on some and hesitate long before attempting others. As has been stated all cases with a lesion in the contralateral lung are doubtful risks as are also cases which at the time of the operation are running a fever or losing weight.

The group of cases best suited for this procedure is the more or less chronic type with a fibrotic lesion which is confined to one lung and quiescent. A second group which does well comprises those with a fibrotic lesion which only show signs of activity, fever, increased cough and loss of weight on attempting any degree of active life. A less favorable type, but one in which the procedure has proved beneficial, includes those cases which have a chronic fibro-caseous lesion. Here, however, one must proceed with greater caution and divide the operation into several stages in order to collapse the lung more gradually. (In these groups pneumothorax treatment is precluded owing to adhesions between the lung and the parietal pleura.)

A fourth group which has done well is that in which a pneumothorax has been only partially successful in collapsing the lung due to the presence of extensive adhesions, usually in the neighborhood of large cavities; because these cavities are held open and their collapse prevented. These patients may have improved up to a certain point, but continue to have positive sputum and run a temperature at times on too great activity.

We have purposely omitted from all consideration the cases of tuberculous empyema in the treatment of which this operation has been performed, believing that in these instances the lung is already collapsed and that these present a totally different problem.

The following table summarizes the results in this series of one hundred cases. There were one hundred and fifty-two thoracoplastic operations.

*Results in 100 Cases*

	Total	Op. Death	Late Death	Post-op. Hæmoptysis	Cured	Imp.	Unimp.	Imp. (lost)
Unilateral....	64	8 (12%)	7 (11%)	1	23 (36%)	16 (25%)	5	4
Bilateral.....	36	16 (44%)	9 (25%)		4 (10%)	5 (14%)	2	

Cured or arrested cases are those who are free of all symptoms after two years and are leading an active life.

The improved cases are those who have been observed for less than two years, some of whom are leading an active life, and some of whom are still undergoing a cure but are considered to have a good prognosis.

The unimproved group comprises those whose sputum is still positive and

## THORACOPLASTY DURING TREATMENT OF TUBERCULOSIS

who continue to show signs of active tuberculosis. A small group has been lost sight of. They were considered to be doing well when last seen, following a period of observation from six to eighteen months.

In estimating the value of thoracoplasty we are confronted by many considerations which are subject to varied interpretations. There are a number of factors which determine the success of operation after the wounds are healed and the patient has passed beyond the immediate care of the surgeon. All these patients still have tuberculosis and they must undergo a rigid, carefully supervised regimen or cure. Part of our lack of success would seem to be directly attributable to the failure of patients to realize the importance of this. Many of them become convinced that they are cured and look upon further hospitalization as an unnecessary hardship and so return to work too soon in spite of all our efforts at dissuasion. They have lost their cough, have gained weight, and have a feeling of well-being which they have not had for years and which without doubt gives them a false sense of security.

Among the class of patients here considered there are many in whom the economic pressure is such that they feel they must return to their duties in their homes. There are others whose ignorance is so great that no amount of argument has any influence on them, they simply do not believe that they are not completely cured and not out of danger.

All the cases require at least a six months' after-cure and some a considerably longer one. They should be watched most carefully and it is here again that the surgeon must depend on the judgment and sagacity of the medical colleague coöperating with him in this work. We have had patients free of all symptoms and leading an active life for five years, who have died of some cause other than their tuberculosis. On these we have been fortunate enough to obtain a post-mortem examination. In the completely collapsed lung there still remained a few nodules well healed, it is true, but which on microscopic examination proved to be large tubercles, "locked up," or "arrested" if you prefer, but still a possible source of danger. One patient who had been free of all symptoms and had led an active life for two and a half years, suddenly without warning had an enormous fatal hæmoptysis and died within five minutes. Several of these cases have undergone more or less severe operations, for acute appendicitis; strangulated hernia, curetage; and have continued well. Most of them, however, have taken, subsequent to this ordeal, an after-cure of several months. Two of our cases have, against our advice, successfully gone through a pregnancy without apparently any ill effects.

We mention these facts in order to emphasize the necessity of keeping these patients constantly under supervision and it would seem that in no class of cases is the value of a follow-up system of greater importance.

The first case on whom we operated lived seven years. During this time she led an active life as a switchboard telephone operator and died of an acute intestinal obstruction from a peritoneal band. We have others con-

sidered as cured who are taxicab chauffeurs, school teachers, secretaries, social workers, and in other active occupations. If these patients remain quiescent for two years they usually continue to do extremely well.

Finally we would impress on your minds what was mentioned early in this paper, the absolute necessity for the surgeon to be associated with some one familiar with the care of tuberculosis, and reiterate again that these operations are only incidents in the cure of those suffering from pulmonary tuberculosis.

The general surgeon in forming an estimate of the value of this operation should realize that these cases are not curable by any known conservative treatment, that many are condemned to a life of invalidism and in addition are a constant menace to the health of others because of their positive sputum and that the majority will eventually die of this disease.

The operation has had real value in their treatment because 33 per cent. of all cases have been returned to an active, useful life of from two to seven years. This compares favorably with any statistics we have seen of gastrectomy for carcinoma or excision of the rectum for cancer, and yet is there anyone who would hesitate to operate on such cases? The mortality rate can be reduced by a more careful selection.

For DISCUSSION see page 126.

# CHANGES IN THE INTRAHEPATIC BILE DUCTS FOLLOWING CHOLECYSTECTOMY

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FROM THE DEPARTMENT OF SURGICAL RESEARCH, CORNELL UNIVERSITY MEDICAL COLLEGE. THIS WORK WAS AIDED BY  
A GIFT FROM MRS. JOHN L. GIVEN IN SUPPORT OF SURGICAL RESEARCH

EMBRYOLOGICALLY the gall-bladder, liver and bile ducts are closely related. In the three-millimetre embryo the liver anlage is distinguishable as a longitudinal groove in the ventral surface of the foregut just below the stomach. From the upper portion a solid mass of cells grows into the septum



FIG. 1.—Normal gall-bladder wall from a dog.

transversum, forming the liver, while the lower part remains hollow and gives rise to the common bile duct, gall-bladder and a portion of the hepatic ducts.

The adult human hepatic, cystic and common bile ducts are all lined with simple low columnar epithelium with occasional goblet cells; while the gall-bladder is lined with a folded mucus membrane covered with tall columnar epithelial cells similar to those of the intestine. The epithelial cells of the dog's gall-bladder and bile ducts closely resemble those of the human specimens. (Figs. 1 and 2.) The parietal sacculi, discovered by Thiele and carefully studied by Beale, are small pouches extending from the bile ducts

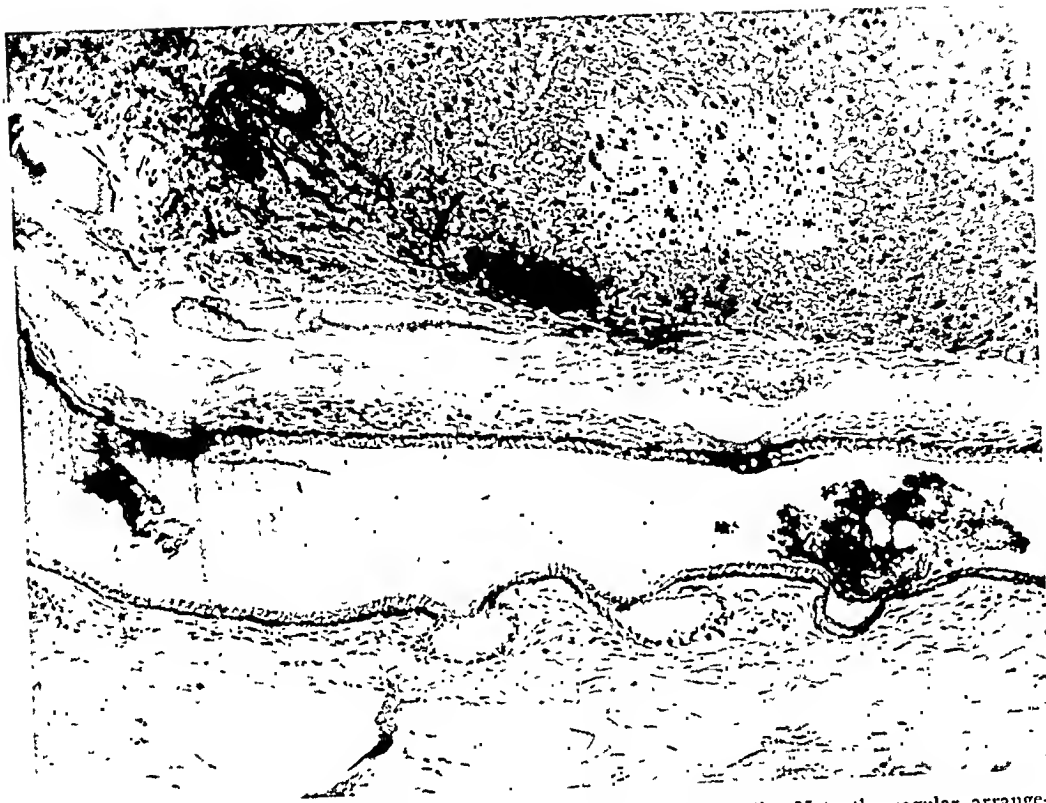


FIG. 2.—Normal intrahepatic bile duct of a dog showing parietal sacculi. Note the regular arrangement of the low columnar epithelial cells.

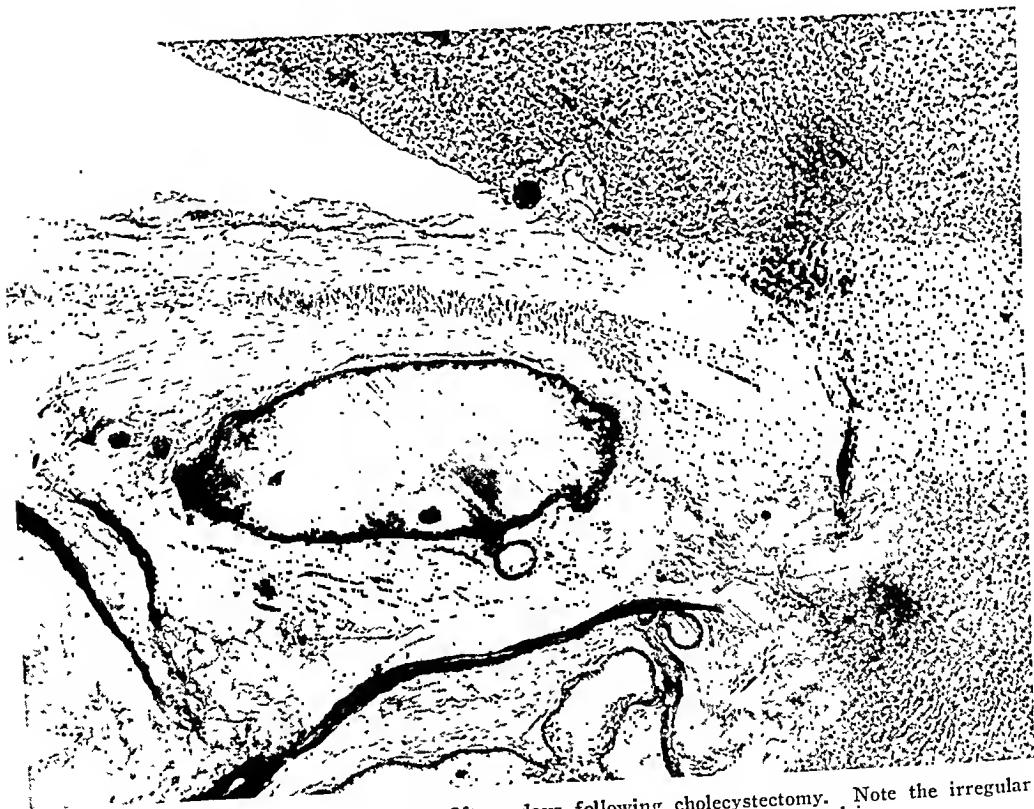


FIG. 3.—Intrahepatic bile duct of a dog fifteen days following cholecystectomy. Note the irregular surface of the duct epithelium with projecting cells and nuclei.

into their fibrous walls and the epithelial lining of these sacculi is continuous with and similar to that of the ducts themselves. (Fig. 2.)

Higgins in a study of the biliary tract of certain rodents, with and without a gall-bladder, chose the mouse, with a gall-bladder, and the rat which shows no vestige of a gall-bladder either in foetal or adult life. The results of this work indicated that the only points of difference between the biliary tracts of these animals, other than that of size, are the presence of the gall-bladder in the mouse and the existence of an extensive branching hepatic plexus around the branches of the portal vein in the rat. This plexus may be an intrahepatic compensating mechanism for the concentration of the bile or

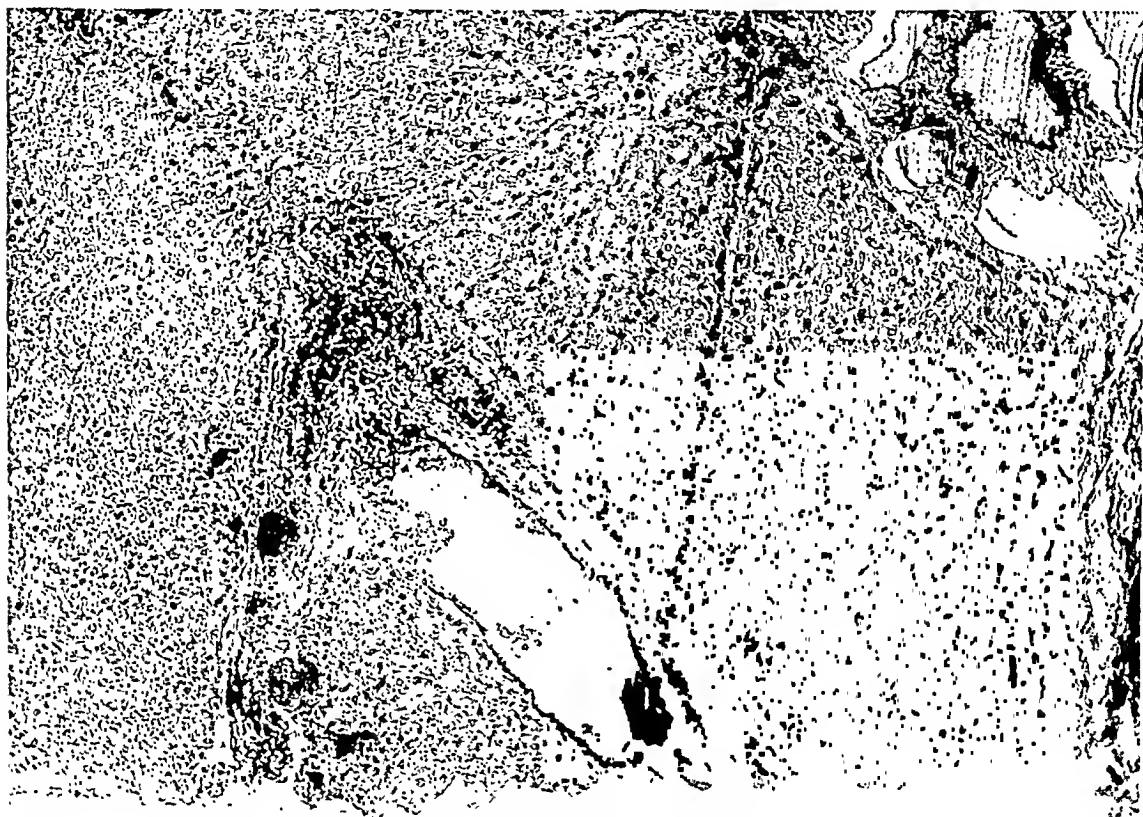


FIG. 4.—Intrahepatic bile duct of a dog fifteen days following cholecystectomy. Note the cords of cells projecting into the lumen.

for other functions analogous to those of the gall-bladder of the mouse. The bile from the hepatic duct of the rat averages, according to McMaster, eight times as much pigment as the liver bile of the mouse.

Definite changes in the extrahepatic bile ducts have been known to occur following cholecystectomy for the past decade. Judd and Mann, in 1917, observed dilatation of all of the ducts outside of the liver after the removal of the gall-bladder and concluded that this enlargement depends upon the competency of the sphincter of Oddi. Mann and Bollman studied the development of jaundice in dogs with common duct obstruction, before and following cholecystectomy. In those animals possessing an intact gall-bladder, bilirubin was found in the blood plasma twenty-four hours after the obstruction; but frequently a definitely positive test was not obtained earlier than thirty-

six hours after operation. Following cholecystectomy common duct obstruction resulted in faintly positive bilirubin tests as early as three hours and in from six to eight hours there was always a positive reaction. Sweet has shown that the total blood cholesterol rises very noticeably after the removal of the gall-bladder; reaching a point almost double the normal and then falling gradually until the curve approaches the normal level forty days after operation. A second noticeable fact is that the peak of the blood cholesterol rise following fat ingestion occurs normally at the sixth hour, whereas after the removal of the gall-bladder the highest point of the curve is reached at the ninth hour. In the dog, without the use of microscopic sections, Sweet



FIG. 5.—Intrahepatic bile duct of a dog forty days following cholecystectomy. Note the folds and villous-like projections extending from the wall into the lumen. These projections are surrounded by the gelatin injection mass; the central clear space indicates solution or loss of a portion of the gelatin during preparation of the section.

has also observed a most elaborate development of the parietal sacculi following cholecystectomy, as compared with their appearance before operation. All of these observations point to a readjustment, probably functional, of the duct system of the liver following the removal of the gall-bladder.

A study of the intrahepatic bile ducts is most satisfactory following injection of the system; and the injection mass must be smooth, homogeneous, and easy to handle. A solution of gelatin fulfills all of these requirements and possesses the added advantage of not melting when fixed in formalin. A colored mass is of great use and gelatin lends itself readily to treatment. Since gelatin is a colloid it is an amphoteric electrolyte and exists in three states according to its hydrogen ion concentration, namely as (a) an isoelec-

tric protein, (b) metal proteinate, and (c) protein acid salt. The isoelectric point of gelatin is, according to Loeb, pH 4.7; and at a pH greater than 4.7 it can combine only with cations forming metal gelatinates, and at a pH less than 4.7 it can combine only with anions, forming gelatin acid salts. Ordinary commercial powdered gelatin has a pH of about 7 and when it is soaked in a silver nitrate solution it unites with the silver, forming silver gelatin. This compound when exposed to light becomes brownish black while a solution turns to a golden brown color. The 12 per cent. silver gelatin solution used in this investigation may be prepared as follows: soak 120 grams of powdered gelatin in 100 c.c. of 1 per cent. silver nitrate (ice cold) for twenty-

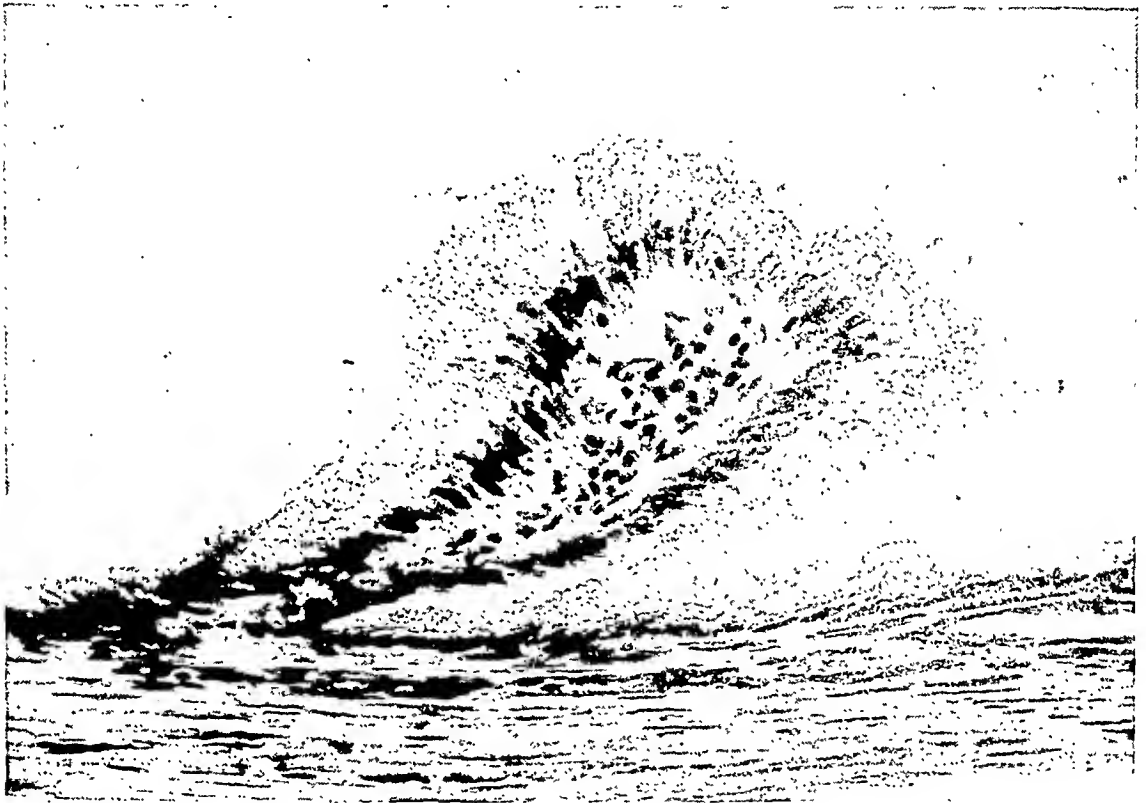


FIG. 6.—High power of a mucous fold projecting into a normal gall-bladder (from same specimen as Fig. 1).

four hours, wash on a filter with distilled water, melt the gelatin on a water bath and add sufficient distilled water to make 1000 c.c. Exposure to light results in a photochemical reaction which produces the colored solution and this silver gelatin, when melted, is a smooth homogeneous colloidal fluid which shows no precipitate or solid particles.

Perfectly fresh intact livers without tears or lacerations must be used and the injections made through the common bile duct. A large pressure bottle holding the melted silver gelatin is connected to a large mercury manometer with a large mercury well, leading to which is an air line connection. The mercury may be raised to any desired level by the compressed air and the injection can be accomplished by a steady, controlled, measured pressure. After filling the tube and cannula completely with the gelatin solution to exclude air, the cannula is introduced and tied into the common bile duct; and



the liver, cannula, tube and pressure bottle are submerged in warm water. Under a pressure of 100 to 180 millimetres of mercury the silver gelatin enters the biliary tract and penetrates to all parts. When the entire biliary system has become filled the liver is swollen, feels turgid and the surface is mottled; the gelatin shows through the capsule and many liver lobules are outlined. Maintaining the pressure, the liver is placed in ice cold 5 per cent. formalin which hardens and fixes the gelatin and preserves the specimen. Sections may be cut from any portion of the liver, embedded in paraffin and cut for microscopic study. The clearing fluids dissolve a certain amount of



FIG. 7.—High power of mucous fold projecting into duct forty days after cholecystectomy. Compare with Fig. 6 from a normal gall-bladder.

the gelatin and in the cut sections the bile ducts are not all completely filled with the injection mass.

Simple cholecystectomy was performed in normal healthy dogs which were allowed to survive for variable lengths of time. No other operation, manipulation or treatments were performed. Normal healthy dogs upon which no operation had been done were used as controls. In each case the dogs were given lethal doses of ether and immediately following death the liver was removed intact with the diaphragm, stomach and duodenum; and injection of the biliary tract made through the common bile duct. The specimen was fixed in ice cold formalin; cubes of liver tissue cut from the interior of the organ near the porta hepatis were embedded in paraffin, cut and stained with hæmatoxylin and eosin.

## THE INTRAHEPATIC BILE DUCTS FOLLOWING CHOLECYSTECTOMY

Specimens were obtained and slides made from six normal dogs and from eighteen dogs following removal of the gall-bladder. All sections from the controls showed without exception a normal low columnar epithelium in the intrahepatic ducts. The sections taken following cholecystectomy presented curious pictures. Fifteen days following operation the epithelium shows areas of apparent disintegration, while in other regions there is a heaping up of the cells in multiple layers with cells containing large irregular nuclei. (Fig. 3.) The epithelial surface is irregular and in numerous sections presents a picture resembling bud formation. In many areas the cell margins



FIG. 8.—Parietal sarculi and small intrahepatic bile duct forty days after cholecystectomy.

can not be distinguished and their large nuclei appear to be projected into the lumen of the duct and in other regions exfoliation seems to have taken place. (Fig. 4.) These changes are found not only in the larger ducts but in the smaller as well. Forty days after operation these changes in the bile duct epithelium have progressed to such a degree that the picture is spectacular. Countless folds, projections and villous-like structures are found extending from the duct walls into the lumina. (Fig. 5.) The epithelium is high columnar with oval or fusiform nuclei, the long axes of which lie at right angles to the bases of the cells. A section of a mucous fold or villus presents a picture practically identical to that of a section of normal gall-bladder wall. (Figs. 6 and 7.) The parietal sacculi are enlarged and the epithelial lining has undergone the same change to high columnar epithelium although no folds or villi are present.

These striking changes lead to one conclusion: cholecystectomy deprives the dog of a useful organ and the closely related bile duct epithelium undergoes changes of adaptation to assume functions normally performed by the gall-bladder.

#### SUMMARY

1. Removal of the dog's gall-bladder produces striking changes in the epithelium of the intrahepatic bile ducts.
2. The low columnar epithelium is transformed into high columnar cells with folds and villi, covered with these cells, projecting into the lumen of the ducts.
3. The beginning of the change is demonstrable fifteen days after cholecystectomy; and at forty days after operation the changes are well advanced.
4. The picture presented by the duct epithelium forty days after the removal of the gall-bladder is that of an exaggeration of the folds projecting into a gall-bladder, and the epithelial cells and their arrangement resemble those of the normal gall-bladder to a remarkable degree.
5. The parietal sacculi enlarge following cholecystectomy and their epithelial cells undergo the same changes as those in the intrahepatic bile ducts.
6. No operation or manipulation other than simple cholecystectomy was performed on these dogs while they were living.

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# OBSERVATIONS ON PEPTIC ULCER

## VII. CLINICAL CORROBORATION OF EXPERIMENTAL DATA

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ONE of the major problems in evaluating experimental data and establishing their clinical applicability is the difficulty of finding exactly parallel clinical and experimental conditions. This is particularly true in the investigation of peptic ulcer. In previous papers one of us (Morton) has described experiments in which the formation of typical chronic peptic ulcers was induced in the stomach and duodenum of dogs in a high percentage of experiments. The case of a recent patient at the University of Virginia Hospital seems to corroborate certain of the experimental data. The history is reported herewith and will be discussed from that standpoint.

**CASE REPORT.**—The patient, a married white woman aged fifty-four years, was admitted to the Medical Service, University of Virginia Hospital, April 1, 1929. The chief complaint was attacks of pain in the upper right quadrant of the abdomen during the past twenty years. For the first two years the attacks had been rather severe but subsequently had become milder and less frequent until five months prior to the time of admission. Since that time the attacks had occurred every two or three weeks. A typical attack had begun with a sense of fullness in the epigastrium and been followed in an hour or two by excruciating pain under the right costal border. The pain had radiated through to the right scapular region and lasted for from two to four hours. She had taken hot soda water and induced vomiting but without relief. Hypodermics had not been tried. The day following the acute pain she had felt feverish, sometimes had a slight chill and the upper right quadrant of the abdomen felt sore and tender. She said she had never been jaundiced but that for a day or two following an attack the stools had been light colored frequently. There had been no dark colored or bloody vomitus and no bloody or tarry stools.

Her family history and past history by systems were negative. She had had nine pregnancies and had nine children living, the youngest aged twelve years.

**Examination.**—The woman was rather obese, her weight 185 pounds, her height 5 feet 1 inch. The temperature, pulse and respirations were normal. The systolic blood pressure was 152 and the diastolic 85. The sclera were clear; all teeth except two lower molars had been extracted. The heart and lungs were normal. The abdomen was obese and there was some tenderness with muscle spasm in the upper right quadrant. The pelvis, extremities and reflexes were normal. The hæmoglobin was 45 per cent.; erythrocytes 4,570,000 and leucocytes 5,000 in each cubic millimetre. A catheterized specimen of urine revealed occasional hyaline casts. The urine contained no urobilin, urobilinogen or bile. The Wassermann reaction was negative; the clotting time 6 minutes; bleeding time 2 minutes and the icterus index 10.4. The Van den Bergh, both direct and indirect reactions, was negative. Examination of the stool revealed nothing abnormal. A test meal was given, 17 cubic centimetres withdrawn and found to contain free hydrochloric acid 30° and total acids 49°. Cholecystographic studies revealed a non-functioning gall-bladder with probable cholelithiasis.

The diagnosis of cholecystitis with probable cholelithiasis was made and operation advised. She was transferred to the Surgical Service April 10, 1929.

*Operation.*—On April 11, 1929, under ether anaesthesia the abdomen was explored through an upper right rectus incision. The liver was small and somewhat scarred. The region of the gall-bladder was a mass of adhesions. The stomach, pylorus and duodenum were normal. The pancreas seemed normal. The uterus was small and the ovaries were atrophied. The appendix showed evidence of former disease and was removed.

The gall-bladder was small and fibrous, contained several stones and its fundus was adherent to the common bile duct which was dilated to about 2.5 centimetres in diameter and contained several stones. The duct was incised and five facettted stones, each about 1 centimetre in diameter, were removed from it. A lead probe was passed through the common duct for some distance up to the hepatic ducts and down into the duodenum without encountering evidence of any other calculi. The gall-bladder was removed from above downward. A small anomalous duct about 1 millimetre in diameter was found entering the fundic third of the gall-bladder directly from the adjacent liver. This duct and the cystic duct and artery were doubly clamped, sectioned and ligated. A Mayo-Robson tube was anchored in the common duct, a cigarette drain placed in the gall-bladder notch of the liver and the abdomen closed in the usual manner.

*Pathologic Report.*—Chronic appendicitis; marked sub-acute and chronic cholecystitis with multiple stones in the gall-bladder and common bile duct.

*Post-operative Course.*—An intravenous infusion of a 5 per cent. solution of glucose was administered immediately after operation. Sips of water were given on the following day and in addition two intravenous infusions, one of saline and one of glucose solution. Proctoclysis was employed for three days after operation. The day after operation the patient's highest temperature was 102°. It subsided rapidly and remained normal and subnormal after the fourth day. A soft diet was allowed on the sixth day and the patient seemed to be in normally good condition except for poor appetite and overanxiety. During this period drainage of bile from the tube in the common bile duct had been progressively less profuse with only slight to moderate leakage of bile by the side of the tube. The stools were normal and the leucocytes numbered 11,000 in each cubic millimetre.

On the tenth day the Mayo-Robson tube came free and was removed. For a few hours bile drained from the wound rather freely and then ceased entirely for twenty-four hours. At the end of that time it recommenced and continued rather freely throughout the remainder of the patient's illness. Food became more and more distasteful to her and it was difficult to induce her to eat anything. She was very pessimistic and overanxious.

On the nineteenth day she became nauseated, began to vomit small amounts frequently and complained of some pain in the upper abdomen. The wound looked healthy and the temperature was normal but the leucocytes numbered 17,000. The stools were light colored and contained no bile. An intravenous infusion of glucose solution was given and the stomach lavaged on the following day. The washings contained some brownish particles of old blood. Another intravenous infusion of glucose solution was given.

On the twenty-first day after operation medical consultants found that the blood pressure was low (systolic 92, diastolic 72) and the heart sounds and pulse weak. Thyroid extract, gr.  $\frac{1}{2}$ , B.i.d. was ordered. On this day three intravenous infusions were given, one of glucose and two of saline solution. Vomiting continued, however, and the vomitus was dark brown in color. Titration of the material showed free hydrochloric acid 46° and total acids 67°. The benzidine test for blood was positive.

For the next two days nothing was given by mouth and proctoclysis and intravenous infusions of glucose and saline were employed. The patient's condition improved very much, no more vomiting occurred and she said that she felt better than at any previous

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time since operation. Bile continued to drain freely from the incision, however, at the point where the tube had been.

Small amounts of fluid by mouth were allowed on the twenty-fourth day. At about 5:30 P.M. the patient felt suddenly weak and when seen the skin was clammy and pale, the pulse very weak and the respiration labored. An intravenous infusion was commenced but in spite of it and various other stimulative measures the patient died after a few minutes.

*Post-mortem Examination.*—(May 5, 1929.) At necropsy the outstanding findings were as follows: The skin and sclera showed no evidence of jaundice. The general peritoneal cavity was clean and free except for numerous adhesions about the site of the cholecystectomy. The ligated stump of the cystic duct was intact. The common bile duct was dilated to about 2 centimetres in diameter and contained a small fistulous

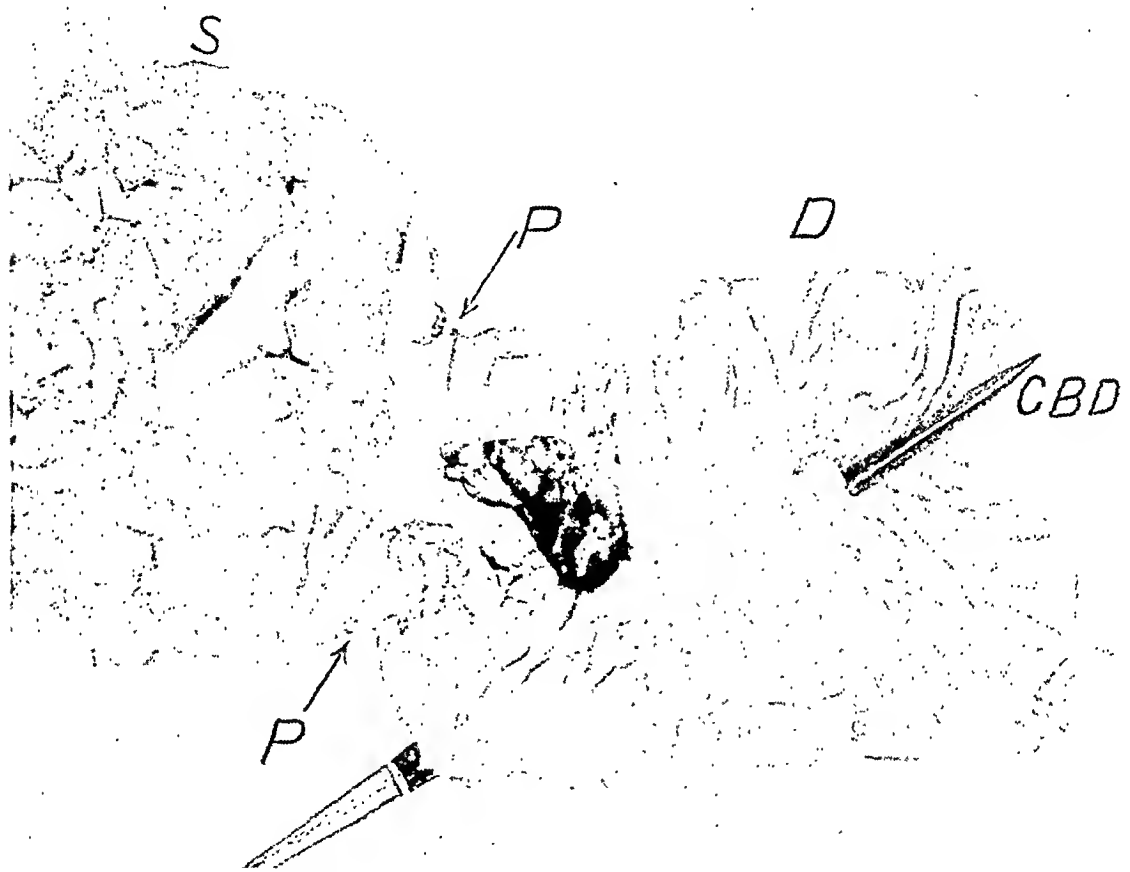


FIG. 1.—Part of the stomach and duodenum showing the large duodenal ulcer and its relation to the papilla of Vater and the pylorus.

opening which communicated with the sinus in the abdominal wall. There was a faceted gall-stone, 1 centimetre in diameter, impacted in the distal portion of the common duct about 2 centimetres proximal to the ampulla of Vater. It apparently caused complete obstruction of the duct. There was a pancreatic stone 0.5 centimetre in diameter, impacted in the distal portion of the main pancreatic duct and about 1.5 centimetres proximal to the ampulla of Vater.

The duodenum was intimately adherent to the head of the pancreas which was moderately indurated in that region. *In the duodenum immediately overlying this area there was a large ulcer which had eroded through the entire thickness of the duodenum so that the base of the ulcer was formed by the pancreas* (Fig. 1). This ulcer was 3.5x2 centimetres in dimension with its long axis parallel to that of the duodenum. It was 7 millimetres in depth and the edges were slightly overhanging. In the base was some dark blood clot. Directly opposite this ulcer and slightly distal to it was a smaller superficial erosion 5x5 millimetres in dimension.

The gastric mucosa showed some congestion and was covered in places with mucus. The entire intestinal tract contained large quantities of dark clotted and decomposed blood. The immediate cause of death was taken to be the severe hæmorrhage from the large duodenal ulcer. The other abdominal and thoracic viscera did not reveal anything of importance. Microscopically the duodenal ulcers were acute and subacute types. The pancreas showed fibrosis and lymphocytic infiltration.

*Discussion.*—In the case just described a succession of circumstances produced changes in the physiologic processes of the gastro-intestinal tract which closely paralleled those induced by certain previously reported experiments on dogs.

Early experiments were reported by Mann and Williamson who transplanted the common bile duct and pancreatic ducts to the lower intestine.



FIG. 2.—An experimentally produced ulcer in a dog.

Following these procedures typical chronic peptic ulcers developed in the duodenum in more than 90 per cent. of experiments. It was found that the same result might be accomplished by surgical duodenal drainage and one of us (Morton) has already reported several series of experiments with this operative procedure.

The operation for establishing surgical duodenal drainage was performed as follows: The pylorus and duodeno-jejunal junction were severed and both of the cut ends of the duodenum closed by suture. The pyloric end of the stomach and the open end of the jejunum were next joined by end-to-end anastomosis. The continuity of the gastro-intestinal tract was thereby re-established. The closed segment of duodenum was then drained into the lower intestinal tract by side-to-side anastomosis with the ileum.

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The results of the experiments were striking in that peptic ulcers developed in the jejunum in 100 per cent. of twenty consecutive experiments. The ulcers were typical subacute and chronic lesions and were grossly and microscopically almost indistinguishable from peptic ulcers found in the duodenum of man. They occurred just distal to the pylorus at the point where the acid chyme emptying from the stomach impinged directly against the wall of the intestine (Fig. 2).

In the clinical case the following succession of events apparently took place: Attacks of cholecystitis, which first appeared twenty years before the time of her admission to the hospital, were followed by the formation of gall-stones, six of which remained in the common duct. But there could not have been very great obstruction to the flow of bile through the duct, for the patient was not jaundiced at any time. That there was some chronic biliary obstruction, however, is evidenced by the icteric index which was 10.4.

A pancreatic stone apparently formed in the main pancreatic duct some time prior to the patient's entry into the hospital, but its presence was not recognized either before or at the time of operation. Some chronic obstruction to the flow of pancreatic juice, however, must have been present.

At the operation a very badly diseased gall-bladder was excised and five stones removed from the common duct. The sixth stone was not found and must have been pushed up into the hepatic duct system and held there by the Mayo-Robson tube which was placed in the common duct. When the tube was removed the stone was allowed to slip down into the common duct distal to the choledochostomy opening. That it did not cause immediate complete obstruction to the lumen of the common duct is evidenced by the fact that no drainage of bile from the incision occurred for a period of twenty-four hours. Complete obstruction must have occurred on the twelfth day after operation, because the profuse flow of bile from the incision and the absence of bile from the stools commenced on that day.

There was nothing in the patient's history to suggest the presence of a gastric or duodenal ulcer and no palpable or visible evidence of one was found at the time of operation. On the nineteenth day after operation, however, she complained of some epigastric pain and nausea and vomiting commenced. Washings from the stomach and the stools contained old blood. At necropsy a large duodenal ulcer and evidence of severe hæmorrhage from it were found. It is impossible to state the exact time at which the ulcer originated. A small ulceration overlying the head of the pancreas might have been missed at the time of operation but, granting such a possibility, the subsequent erosion of tissue must have been very rapid to have made possible the formation of the large and deep ulcer crater which was found at necropsy.

The close parallel between the conditions bearing on the formation of the clinical and the experimental ulcerations is obvious. In the experiments the formation of chronic peptic ulcers followed surgical duodenal drainage which prevented the discharge of the alkaline pancreatic juice and bile into



the pyloric portion of the intestine. The ulceration occurred just distal to the pylorus.

In the clinical case the ulcer probably formed and certainly progressed rapidly following interference with the discharge of bile and pancreatic juice into the duodenum. Pancreatic juice could hardly have been discharged freely past the stone in the pancreatic duct and bile must surely have been completely excluded from the duodenum by the impacted stone in the common duct. As in the case of the experimental ulcers this ulcer occurred just distal to the pylorus. Gross and microscopic examination of the two types, experimental and clinical, revealed identical characteristics.

Because of the similarity in location, structure and other characteristics of the ulcers and because of the close parallel between the changed physiologic processes in each instance it seems reasonable to suggest that the findings in the case reported present corroborative evidence in favor of the applicability of certain previously reported experimental data to the clinical problem of the ætiology of peptic ulcer.

#### SUMMARY

The difficulty of evaluating and establishing the clinical applicability of experimental data was mentioned. A case was reported, the history of which had led to an operation for cholecystic disease. The appendix and gall-bladder were excised, multiple stones removed from the common bile duct and choledochostomy performed. There was no palpable or visible evidence of ulceration of the stomach or duodenum at that time. The patient died twenty-four days after operation of an acute hæmorrhage from a large duodenal ulcer which was discovered at necropsy. An additional gall-stone was found to have obstructed the lumen of the common bile duct completely and a pancreatic stone was partially obstructing the main pancreatic duct. The formation of the ulcer was attributed to the interference with the discharge of alkaline pancreatic juice and bile into the duodenum. Attention was called to the formation of identically similar ulcers in dogs following surgical duodenal drainage, an experimental procedure which diverts the pancreatic juice and bile from the region of the pylorus. It was suggested that the findings in the case reported presented corroborative evidence in favor of the applicability of one of the authors' (Morton's) previously reported experimental data to the clinical problem of the ætiology of peptic ulcer.

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# TUBERCULOSIS OF THE SIGMOID COLON SIMULATING A PRIMARY MALIGNANT LESION\*

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PRIMARY ulcerative lesions of the colon are rarely tuberculous. The frequency with which such lesions are mistaken for tuberculosis is best illustrated by the fact that many patients with chronic ulcerative colitis examined at The Mayo Clinic previously have received diagnoses of tuberculosis of the colon. Only an occasional case justifies such confusion, for usually tuberculous ulcerative colitis presents a picture vastly different from that of chronic ulcerative colitis, both from the proctoscopic and the röntgenologic standpoints. Tuberculous ulcerative colitis is usually secondary to pulmonary or other primary tuberculosis. Acid-fast bacilli in the stools do not necessarily connote the existence of intestinal tuberculosis. Thus, Brown and Sampson found the sputum free from acid-fast bacilli in only 9 per cent. of 277 patients with pulmonary tuberculosis who also had intestinal lesions. Again, Nüssel in 120 patients with pulmonary tuberculosis of whom only six had intestinal tuberculosis, found acid-fast bacilli in the stools of 110 (91 per cent.); or, the stools of only 9 per cent. were free. Klose, in sixty cases in which acid-fast bacilli were found in the sputum, found the bacilli in the feces of fifty-five; in only six of these cases was there a suggestion of intestinal tuberculosis.

Clinically, a primary lesion may not always be found even in cases of ulcerative tuberculosis of the colon. There is a hyperplastic type of tuberculosis which may be primary in the colon. This occurs most frequently in the cæcum or ileocæcal coil of the intestine and the frequency of its occurrence decreases in direct ratio to its distance from the cæcum; hence the hyperplastic type of rectal tuberculosis is probably the rarest of all forms of tuberculosis. One of us (Bargen) has reported such a case.

In 100 cases of tuberculosis of the colon, reviewed by Lockhart-Mummery, six were of the sigmoid portion, and one was of the rectum. In records of 22,725 necropsies reviewed by Gant, an incidence of primary tuberculosis of the colon was noted in 7.22 per cent., emphasizing further the infrequent occurrence of this disease in the colon.

Mailer, in 1927, emphasized the paucity of the occurrence of hyperplastic tuberculosis of the colon in general and, in particular, the infrequency of the coexistence of tuberculosis of the sigmoid and other lesions. He stressed the difficulties in diagnosis and emphasized the importance of diagnosis to express prognosis.

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Carman, in his book on "Röntgen diagnosis of diseases of the alimentary canal," did not present a röntgenogram of a tuberculous sigmoid colon, and such a specimen of tuberculosis of the sigmoid colon is not filed in the museum of the Royal College of Surgeons.

W. J. Mayo as early as 1899 stressed the infrequent occurrence of tuberculous lesions of the sigmoid colon when he, in a report of seven cases of tuberculosis of the colon, noted two in this region. Again, in 1909, he called attention to the rarity of tuberculosis of the sigmoid colon in comparison to that in the cæcum.

Brown and Sampson, in 1926, called attention to the fact that stenosis of the colon occurred more commonly in primary than in secondary intestinal tuberculosis.

A further interesting observation has been made by Yeomans, that tuberculous ulcers of the sigmoid colon encircle the bowel, following the course of the blood vessels, as in the ileum. This might explain the similarity of the filling defect as detected by Röntgen ray, in certain malignant and tuberculous lesions. Tuberculous peritonitis with tuberculous colitis occurs occasionally. Lemon noted only ten cases of tuberculous peritonitis in a series of fifty cases of ulcerative tuberculosis of the colon. It is a well-known fact that in the hyperplastic type of intestinal tuberculosis the incidence of peritonitis is much smaller than in other forms of the disease.

The rare occurrence of tuberculosis of the sigmoid colon, the infrequency of tuberculous peritonitis with tuberculosis of the colon, its close similarity to other obstructive lesions of the colon, and the difficulties encountered in its diagnosis, led us to report the following cases. The possibility of there being two lesions is fully appreciated, but the ease of explaining symptoms and visible pathologic evidence on the basis of one lesion suggested careful consideration of tuberculosis in similar cases in the future.

CASE REPORTS.—CASE I.—A woman, aged fifty-nine years, a housewife, was admitted to The Mayo Clinic April 9, 1929, complaining of "bowel trouble." As a girl of six years a short attack of indeterminate jaundice had developed but there had been no further recurrence. A pterygium had been removed from the left eye when the patient was thirty-nine years old. For many years she had suffered from mild constipation, which gradually had increased until she had used cathartics occasionally for relief. For the two years before she came to the clinic she had noticed considerable flatulence and eructation. In September, 1928, there had been an increase in constipation, with some postprandial bloating, and her appetite had become poor. In December great difficulty in evacuation of the bowels had been experienced, although much castor oil had been administered by mouth. The stools had become small and somewhat "pencil-shaped." In February, 1929, she had begun to pass mucus in the stools, and although she had suffered from hemorrhoids for several years, with occasional streaking of stools with blood, blood had not been noted admixed with stools until one month before admission to the clinic. Two weeks before admission, diarrhœa had developed, and many of the stools had been admixed with mucus and blood. Straining at stool had caused passage of considerable blood. A point to be stressed is the fact that the diarrhœa had persisted at night. Slight fever had occurred from time to time, with intermittent periods of obstipation, and subsequent stools had been foul in odor. For a few months prior to admission the patient had experienced some tachycardia and dyspnœa when bloating had

occurred. Urinary symptoms had been practically absent. During her illness and for three weeks prior to admission symptoms had been relieved considerably by the constant taking of medicated oils.

The patient was markedly emaciated and sallow. The mucous membranes were pale. The tonsillar beds were somewhat scarred. Many teeth had been removed and those which remained were carious. Examination of the thorax revealed some emphysema of the lungs. The heart was slightly enlarged, with a systolic murmur at the apex replacing the first heart sound. The abdomen was distended and tympanitic, with generalized rigidity which made examination of the viscera impossible. Nevertheless, a peculiar doughy feel was imparted to the palpating hand. The abdomen was not especially tender. Hemorrhoids and an anal fissure were found on rectal examination. Pelvic examination disclosed a lacerated cervix. The uterine adnexa were not felt. Röntgenograms of the thorax showed evidence of pleuritic thickening at the base of the right lung and extending upward to the level of the fourth rib; also there were adhesions to the diaphragm. It was suggested by the röntgenologist that this might be metastatic pleural involvement. A röntgenogram of the colon, after belladonna had been administered, disclosed a filling defect in the middle portion of the sigmoid colon. The röntgenologic diagnosis was carcinoma. (Fig. 1.) The proctologist noted that he could not view the sigmoid due to sharp angulation, that the hemorrhoids and the anal fissure might account for the bleeding, but that he felt that there was some pathologic condition above the point seen because the motion of



FIG. 1.—A filling defect in the middle portion of the sigmoid colon.

the bowel was not as free as usual. The hemoglobin was estimated at 74 per cent. (Dare); erythrocytes numbered 5,000,000 and leukocytes 14,300 for each cubic millimetre. Albumin in the urine was graded 1+ and the urine contained an occasional erythrocyte and a few leukocytes. The Wassermann reaction of the blood was negative.

The patient was admitted to the hospital with a diagnosis of malignant lesion of the sigmoid colon, and, following proper pre-operative treatment, exploration was done April 25, 1929. An incision was made low in the middle line and the operator exposed a very markedly thickened peritoneum. This was opened, and numerous coils of intestine were found adherent to each other and studded with tubercles. The general cavity was not subjected to exploration but it was assumed that the lesion was one of generalized abdominal tuberculosis. The operation was limited to abdominal exploration.

Since the operation, the patient's progress has been uneventful and the prognosis so far seems hopeful.

CASE II.—A man, aged forty-four years, a freight clerk, was admitted to The Mayo Clinic March 19, 1929, complaining of "stomach trouble." The present illness had begun in June, 1928, with an uncomfortable feeling in the upper left part of the abdomen on bending the body. Pain had not been experienced at this time. The patient had visited a physician and had been given a modified Sippy diet for three weeks. At the end of this time the patient's weight had dwindled thirty pounds. Feeling that this diet was

of little benefit, he had reverted to a normal diet and had felt very well until December, 1928. At this time, he had begun to notice mild postprandial epigastric pain. He had sought naturopathic treatment; this had been followed by increase in epigastric distress and the further loss of twenty-five pounds in weight. The epigastric pain had followed meals immediately and had been of a burning character. Sometimes a stinging pain had radiated to the left shoulder, and had lasted only a few minutes. The abdominal pain gradually had diminished until the next meal. Since December, 1927, the patient had been suffering from constipation, with intermittent exacerbations of difficulty in movements of the bowel. In January, 1929, griping pains in the lower part of the abdomen had developed; these had been relieved by evacuation of the bowel. For one week before admission to the clinic he had taken a cathartic twice daily, with the result that distress in the epigastrium and in the lower part of the abdomen had become much less. There had not been any blood in the stools. In spite of a good appetite during the course of his illness, from one to two pounds of weight had been lost weekly, and

within ten months fifty-seven pounds had been lost. In January and part of February the patient had experienced pain in the region of the bladder when it had been full, and a sharp pain in the end of the penis on urinating.

The patient showed evidence of marked loss of subcutaneous fat, and the mucous membranes were pale. There was an old scar on the right cornea. The pharynx was hyperæmic. The chest seemed normal on auscultation and percussion. The abdomen was rigid, and not especially tender, but nothing could be made out concern-

FIG. 2.—A filling defect of the distal part of the sigmoid colon.

ing the viscera because of the rigidity. The doughy sensation was even more marked in this case. The genitalia were normal; rectal examination did not reveal anything of note. Röntgenograms of the thorax gave negative evidence. Röntgenograms of the colon, after belladonna had been given, showed a filling defect of the distal part of the sigmoid colon that was said to be caused by carcinoma. (Fig. 2.) Proctoscopic examination revealed internal and external hemorrhoids. The urine was negative to examination. Hemoglobin was estimated at 54 per cent. (Dare) erythrocytes numbered 4,120,000 and leucocytes 5200 for each cubic millimetre. Chemical examination of the blood gave negative results. After a test-meal, examination of gastric content disclosed total acidity of 44 and free hydrochloric acid of 30 in terms of cubic centimetres of tenth-normal sodium hydroxide. The Wassermann reaction of the blood was negative.

The patient was admitted to the hospital with a diagnosis of malignant lesion of the sigmoid colon. Following adequate pre-operative preparation, abdominal exploration was performed under general anæsthesia March 29, 1929. A low left rectus incision was made, and a typical condition of tuberculous peritonitis was found; the peritoneum was thickened and studded with tubercles. All of the coils of the intestine, and the omentum which lay in the vicinity of the opening, were adherent to each other and to the abdominal wall; these viscera also were studded with tubercles. A specimen removed for diagnosis showed the condition to be due to tuberculosis. Because of free

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bleeding, an attempt was not made to examine the sigmoid colon and the wound was closed without further exploration.

Except for four days following operation, the patient's temperature was practically normal. There was a flare-up of the old corneal scar, with mild iritis, but this was well under control. The incision healed without difficulty and the patient was dismissed from the hospital and clinic with his condition noted as satisfactory. A recent follow-up inquiry has elicited the information that he is distinctly weak and is again suffering from abdominal cramps.

*Comment.*—Tuberculous lesions of the colon, as a primary disease, have been reported. When they occur, their common site is the ileocecal region. Tuberculosis of the sigmoid colon is one of the rare forms of tuberculosis of the colon. Definite proof does not exist that the primary lesion in these two cases was in the sigmoid colon but several observations suggest this. The surgeons who performed exploration in these cases noted that the greater bulk of the lesion was in the left lower part of the abdomen. Obstruction occurred in the sigmoid colon. The absence or scantiness of the bleeding in the presence of a large obstructive lesion argues against the presence of a malignant condition. Rankin and Yeomans previously have noted the similarity of the röntgenographic defects produced by tuberculous and malignant lesions. The absence of tuberculous lesions elsewhere than in the sigmoid colon is noteworthy. With these facts in mind, it would seem hardly necessary to search for two types of lesions, that is, for both a malignant and a tuberculous condition, to explain the pathologic data.

Pincoffs and Boggs noted that in tuberculosis of intra-abdominal origin, masses of tuberculous nodules will occur in various places, and that there is more matting of viscera than with tuberculosis of distant origin. The conditions indicative of intra-abdominal origin of the process obtained in both of the cases reported in this paper.

Bloodgood called attention to the significance of leucocytosis in the diagnosis of obstruction with tuberculosis, and he has further emphasized the unfavorable prognosis in most such cases.

The absence of lesions in the rectum and in the rectosigmoid portion of the colon, as noted by proctoscopic examination, argues against the presence of an ulcerative type of lesion, and further, the absence of deformity or of any defect of the colon elsewhere is evidence against the presence of tuberculosis of the proximal portion of the colon and in favor of the disease being of the hyperplastic type.

The peculiar feel of the abdominal wall, as imparted to the palpating hand, in both of these cases, and the associated tuberculous peritonitis, are most significant.

The suggestion is, then, that we may be dealing here with primary tuberculosis of the sigmoid colon, and with tuberculous peritonitis. An effort has been made to set forth some of the diagnostic data.

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# THE SURGICAL MANAGEMENT OF STONE IN THE URETER

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IN THE conduct of a large surgical practice many cases of urologic disease are encountered and the coöperative efforts of the surgeon, urologist and röntgenologist are essential for diagnosis and therapeutic management. The exactness of the methods of urologic diagnosis is exceeded only by the revelations of the aseptic scalpel. While the surgeon's hand will be guided by the data obtained by the use of the cystoscope and X-ray, his procedure must be counseled by sound judgment when the actual disease is exposed.

Obstruction in the drainage channels of the body is always a serious matter and relief is frequently an urgent question of life or death. Obstruction in the upper urinary tract is usually incomplete and lends itself to more deliberate consideration because of the large factor of safety and the bilateral disposition of its important organs. The opportunity for investigations so afforded should be utilized to determine by combined cystoscopic and röntgenologic examination the exact location and number of stones, the presence and degree of infection, the condition of the kidney above the obstruction and the functional and anatomical status of the opposite kidney. Chemical studies of the blood for the quantitative estimation of urea, creatinin, uric acid and glucose will serve to indicate the extent of total renal impairment, the advisability of certain preoperative precautionary measures and to act as a guide in the progress of the patient's condition. Close observation of urinary excretion as to quantity, specific gravity, the presence or absence of albumen and sugar and the microscopic contents will yield information of great value regarding renal capacity, infection, and degenerative lesions. Repeated dye tests serve as a measure of excretory function and should be compared with chemical studies of retention products in the blood.

The physical examination of the patient should be carefully made. Palpation for renal enlargement and tenderness will often give information which is otherwise unattainable. Polycystic disease of the kidneys, renal tumor, and peri-nephritic abscess are only a few of the conditions in which palpatory findings are important in diagnosis. The lower urinary tract and pelvis may contain associated lesions of the uterus and adnexa and the prostate gland, so that vaginal and rectal examinations should not be neglected.

Not all abdominal scars in cases of ureteral stone are evidence of mistaken diagnosis. We have frequently found appendicitis associated with stone in the ureter and have attended to both lesions at the same operation. In fact, in most cases of stone in the ureter, unless conditions forbid, we remove the appendix and the stone through the extra-peritoneal incision.

The percentage of ureteral stones which pass spontaneously has been



variously estimated and is probably about seventy-five per cent. This figure will vary in the experience of the individual surgeon depending upon his opinion as to the advisability of intervention and upon counsel of an associated competent cystoscopist. We believe that when there is any question as to the policy of watchful waiting, once the presence of a stone in the ureter has been established, the safer course is to proceed at once with its removal, provided there are no forbidding circumstances. It seems to us to be unwise counsel to tell a patient who has a stone in the ureter, even in the absence of symptoms, to wait for its passage or for the appearance of acute symptoms. The possibility of renal damage from back pressure and infection is ever present and is a price too dear to pay for avoiding operation or cystoscopic examination. The expert cystoscopist will succeed in the removal of many ureteral stones. The necessary diagnostic manipulations with the ureteral catheter may suffice to dislodge the stone and to favor its passage. Failing in this, deliberate and, if necessary, repeated attempts to dilate the ureter by catheter or other device and to change the position of the stone will usually accomplish its expulsion into the bladder whence it readily gains its exit. A certain degree of caution should be exercised in persistent efforts to remove a stone. Manipulations with a catheter, provided drainage is not adequate, may accentuate an already present renal infection and may necessitate a nephrectomy. Some patients are so intolerant to cystoscopy, that repeated catheterizations of the ureter are impossible and they prefer surgical removal of the stone.

The size of the stone unless more than 2 centimetres in diameter does not influence materially the procedure to be adopted for its removal. A small stone difficult to detect by X-ray may cause complete obstruction by reason of surrounding inflammatory cedema and one will often experience considerable difficulty in finding so small a stone at operation. In such cases of small obstruction stone it is advisable with the aid of the cystoscope to insert a small catheter beyond the stone thereby relieving the obstruction, and to allow it to remain in place for forty-eight (48) hours when the inflammatory reaction around the stone will have subsided. The ureter may now be dilated by inserting a series of graduated catheters; a large stone may remain in the ureter for a long time without causing acute symptoms and will be best treated by ureterolithotomy. Multiple stones in the same ureter should be removed surgically because cystoscopic procedures would require repeated attempts with the consequent liability of renal damage. Stones in both ureters or stone in one ureter with a lesion of the opposite kidney require earnest consideration as to the order of the procedure; accurate data by the use of the X-ray, cystoscope and functional tests should first be obtained. Ordinarily, the side presenting the acute symptoms should receive first attention. Otherwise, the initial procedure should be directed toward the side having the better function. When there are complicating lesions of the lower urinary tract, as obstructive hypertrophy of the prostate, then the merits of the individual case must determine the course of action. Usually, when

the prostate is the cause of much residual urine, cystostomy or prostatectomy should precede any attempt to correct a lesion of the upper urinary tract.

When the kidney above a stone in the ureter is extensively diseased as in pyonephrosis there is nothing to be gained by removal of the stone unless the kidney and a large portion of the ureter are also removed. It may be difficult to determine the condition of the kidney by cystoscopic methods so that when uncertainty exists the surgeon is obliged to explore the kidney and let the findings of direct inspection decide for or against its removal. A stone should not be allowed to remain in the ureter after nephrectomy because of the likelihood of a persistent fistula and disability from continued infection in the remaining stump of the ureter. Many cases of this type require a subsequent operation. The stone in the ureter because of its low position may be inaccessible at the time of nephrectomy and should then be pushed into the bladder with the aid of a sounder catheter inserted into the upper ureter.

We are presenting the following data on ureteral stones as a record of experience at the Lankenau Clinic from 1910 to 1925. Certain factors which influence the disposition of an individual case do not of necessity appear in statistical data; consequently, expressions of opinion and conclusions may not always have the support of figures.

One hundred thirteen patients with stone in the ureter were admitted to the Lankenau Hospital during the above period; sixty-six were operated upon and forty-seven were treated by cystoscopic methods.

In ninety-eight of the 113 cases the stone was in the lower ureter. Stones in this position are favorable for cystoscopic manipulation unless certain contra-indications are present. They may also be readily removed by ureterolithotomy. When a stone has remained for some time in the upper ureter usually at the ureteropelvic juncture it is firmly fixed, obstructs the passage of a catheter and will cause rapid and progressive impairment of renal function. Cystoscopic manipulations for dislodging it are usually of no avail. Rescue of the kidney demands prompt removal of the obstruction by uretero or pelvicalithotomy. Discovery of a stone in the upper ureter when the symptoms are mild and of short duration will permit a reasonable time for its descent and possible spontaneous or induced passage. A stone does not often lodge in the middle third of the ureter, but when in this position the procedure to be adopted for its removal will depend on the acuteness of the symptoms and the condition of the kidney above it. When a stone in this position is not causing complete obstruction and the degree of infection is not severe, then cystoscopic manipulations with a catheter in an effort to dislodge it may be tried. They are often unsuccessful. Surgical removal of a stone in this position is a little more difficult than when it is in the upper or lower third, but is to be preferred because cystoscopic attempts are less certain and attended by greater risk.

In this series the stone was located in the right ureter in fifty-seven and in the left ureter in fifty-six instances.

There were forty-seven patients with stone in the ureter who were not operated on. Forty were males and seven were females. Their ages by decades were: one in the second decade, ten in the third, sixteen in the fourth, thirteen in the fifth, five in the sixth, and two in the seventh decade. In twenty-nine patients the history was acute or of only several weeks' duration. The eighteen remaining patients had had previous attacks with an average duration of symptoms of a little over three years; the longest being ten years and the shortest three months. Two patients had previously passed stones. In this group of forty-seven unoperated cases there were eleven patients who passed the stone from the ureter as the result of cystoscopic manipulations. The remaining patients were discharged from the hospital either because they refused operation or cystoscopic treatment or because they were told to allow more time for the stone to pass spontaneously.

There were sixty-six patients (forty-three males and twenty-three females) who were operated on for stone in the ureter. The ages of these patients by decades were: twenty-two in the third decade, nineteen in the fourth, twelve in the fifth, ten in the sixth, and three in the seventh decade. In fourteen patients the history was that of an acute onset or of symptoms of only several weeks' duration prior to admittance to the hospital. The remaining fifty-two patients had had one or more previous attacks with an average duration of symptoms of 3.2 years; the longest being thirty years and the shortest three months. Three patients stated that they had previously passed a stone.

*The Operative Treatment of Stone in the Ureter.*—Before proceeding with operative measures for removal of a ureteral stone it is essential, as previously noted, that an accurate diagnosis has been established; that the urologic status of the patient has been determined with particular reference to the opposite kidney, and the total renal functional capacity as revealed by chemical studies of the blood; that co-existent extra-urinary disease has been eliminated or taken into consideration, and in the case of the bad-risk patient that sufficient preoperative preparation has been carried out to the complete advantage of all favorable factors. When all this has been done there are still a few cases in which the choice of procedure will devolve upon the judgment of the surgeon.

The removal of a stone from the ureter may be a simple affair or a difficult undertaking, and in the event of certain complications, particularly post-operative, a wide surgical experience may be necessary to get the patient well. Consequently these patients fare better in the hands of the general surgeon or in those of the urologist who has had a general surgical training.

The choice of treatment in a case of stone in the ureter should be decided upon only after the evaluation of certain facts and circumstances. A large percentage of stones, about seventy-five per cent., will pass spontaneously. Many or most of the remainder can be made to pass by expert cystoscopic manipulations. The sifted failures of the above, and those stones obviously

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unsuited for cystoscopic treatment are properly entrusted to surgical methods. Not every surgeon enjoys the coöperation of an expert urologist; consequently he will be called upon to remove more stones surgically. And properly so, since the results of operation are more satisfactory than ill-advised or improper procedures in the hands of an inexperienced cystoscopist.

It will be found advisable to make an X-ray examination for localization of the stone within twenty-four hours before operation because not infrequently the stone changes position or passes out of the ureter entirely.

Ureterolithotomy through an extraperitoneal approach is the operation of choice for stone in the ureter. To approach the upper third of the ureter, the incision is placed in the loin and resembles the one used for nephrectomy. This incision permits possible manipulation of the stone back into the pelvis of the ureter whence its removal can be accomplished with less traumatism than from the ureter proper. The kidney also is rendered available for inspection. The incision may also be extended to care for a stone in the middle third of the ureter. Or the latter may be approached through an incision to the lateral side of the rectus when it is necessary to use more care in working one's way down to the ureter by displacing the peritoneum toward the mid-line. A point of importance to remember is that the ureter is often closely adherent to the peritoneum and in the dissection is carried forward with it. Access to the lower ureter may be obtained through an incision to the lateral side of the rectus or by an incision just above Poupart's ligament. In this position the peritoneum is easily reflected and the base of the bladder exposed. Manipulations may be difficult because of the depth of the wound. The ureter should be identified and followed down to its juncture with the bladder. In performing uréterolithotomy the ureter should be secured and held by an encircling tape. This device also prevents the escape of a stone beyond reach into the upper ureter. When the stone has been found it is preferable to work it into another position in the ureter so that the longitudinal incision for its removal will not be placed in the inflamed tissues of the ureter surrounding a lodged stone. After the removal of the stone the passage-way to the bladder must be cleared by passing a ureteral catheter or probe, otherwise a persistent ureteral fistula will develop. A stone just above the bladder may be so firmly fixed that it cannot be dislodged upward and removal *in situ* may be very difficult. In this condition it may be possible to push it into the bladder and remove it by cystotomy or allow it to pass spontaneously. Occasionally, when a large stone is obstructed at the bladder juncture its removal may require combined intra-ureteral and intravesical manipulations. The disposition of the ureteral incision is a matter of choice. It may be left open or it may be closed by several interrupted sutures; the results are equally good. A drain must be placed down to it because there is nearly always some leakage of urine for several days. When there is much infection above the stone it is probably better not to suture the ureteral incision because free urinary drainage will be beneficial. If the incision has been closed by suture there is often temporary

partial obstruction caused by localized œdema. A stricture rarely follows the healing of anal ureter incision. When it occurs it is usually the result of the healing of a necrotic area which formed the bed of the stone or from the effects of a peri-ureteritis. A stone just above the bladder may be accessible for removal through an incision in the vault of the vagina. This applies particularly to stones which are palpable by vaginal examination.

The apparent simplicity of ureterolithotomy may be deceptive and lead to the chagrin of the surgeon who may fail to find a stone which has been demonstrated by X-ray and verified by cystoscopic examination. In a stout subject the approach may be very difficult. In three patients of this series the stone could not be found. In one of these the X-ray later showed the stone. Another patient returned three weeks later and passed a stone three centimetres in length.

Calculus ureteral obstruction is nearly always accompanied by infection of the corresponding kidney. There may be only a slight degree of pyelonephritis which will readily subside when urinary obstruction has been relieved. The infection in the kidney may be aggravated by prolonged obstruction and progress to the stage of pyonephrosis for the relief of which nephrectomy is obviously required. In not a few instances persistent efforts to dislodge a stone by cystoscopic manipulations have incited rapidly progressive renal infection with markedly septic manifestations—a condition commonly known as “acute surgical kidney,” or “carbuncle of the kidney,” an immediate nephrectomy must be done. As previously noted, mild pyelonephritis usually subsides after removal of the ureteral stone, but in the cases of more severe infection with hydronephrosis the surgeon may be in doubt as to the disposition of the kidney, especially when inspection is impossible. In these circumstances removal of the stone and drainage of the ureter may relieve the condition and recovery ensue. In the event the ureteral fistula fails to close or there are signs of progressive renal infection, then the kidney must be removed.

It must be admitted that an inexcusable number of patients in whom a stone has been found in the ureter possess an abdominal scar from a previous appendectomy. In many of these the operation had been done for symptoms undoubtedly caused by the stone. The error may be excusable in those cases where there has been no history of severe pain or colic and in which the symptoms for the most part have been persistent or recurrent dull pain in the right lower abdomen with mild reflex gastric disturbances. Such symptoms are not uncommon with stone in the ureter, but occur with greater frequency in appendicitis. Chronic appendicitis or some other surgical lesion may co-exist with a stone in the ureter. To correct one condition and not the other is to obtain an unsatisfactory result. We venture to say that some patients are unrelieved of their abdominal symptoms following removal of a stone from the ureter. With this in mind, it has been our practice when operating for ureteral calculus to remove the appendix as well as the stone where the symptoms have warranted this procedure. Usually, the operations

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can be done through the same incision. The appendix is removed first, the peritoneum securely closed and then an extraperitoneal exposure of the ureter is made.

### *Summary of Operative Data*

	Cases
Ureterolithotomy . . . . .	31
Stones removed from two incisions in ureter . . . . .	1
Two stones removed . . . . .	1
One stone removed and another pushed into bladder. (This patient had a nephrectomy later because of a ureteral fistula.) . . . . .	1
Double ureter . . . . .	1
Kidney and ureter removed later . . . . .	1
Ureterolithotomy combined with appendectomy . . . . .	12
Salpingectomy . . . . .	1
Ureterotomy combined with transvesical removal of stone . . . . .	4
Nephrectomy five weeks later—stones in remaining kidney. . . . .	1
Ureterotomy combined with removal of stone from lower ureter via vagina. . . . .	1
Exploration of ureter extraperitoneally and by cystotomy but no stone found. . . . .	3
Stone later shown by X-ray . . . . .	1
Returned three months later and passed a stone 3 inches in length . . . . .	1
Pelviolithotomy. . . . .	3
Nephrectomy. . . . .	5
Primary. . . . .	3
Secondary . . . . .	2
Transvesical removal of stone from ureter . . . . .	7
Stone pushed back in ureter and then removed through loin . . . . .	1

*Mortality.*—There were no deaths following simple removal of a stone from the ureter.

One patient died following nephro-ureterectomy for infected kidney caused by a stone obstructing the lower ureter.

# PROBLEMS RELATED TO SURGICAL LESIONS OF THE KIDNEY \*

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CERTAIN well-defined principles have been established in the treatment of most of the surgical lesions of the kidney. However, the problems encountered in the consideration of the surgical lesions of the upper part of the urinary tract are not confined to surgical methods which today are fairly well understood and universally employed. Many of the technical surgical procedures have been so uniformly standardized that little may be presented to add to present-day knowledge of the execution of the usual operations on the kidney. Many problems are presented in the determination of whether a lesion exists, whether it is best treated by surgical or nonsurgical methods, and if it is determined to be surgical, whether conservative or radical procedures shall be employed.

It is not my purpose to review the various surgical lesions of the upper part of the urinary tract, but to present for your consideration some of the problems attendant on the treatment of lithiasis, renal tuberculosis, and neoplastic disease.

We are all aware of the painstaking effort, so necessary on the part of the urologist, to establish a diagnosis of a surgical lesion of the urinary tract and the necessity for care in the selection of procedures incident to urologic diagnosis, and competent interpretation of data. The symptoms of intra-abdominal disease and those of disturbances of the urinary tract are often sufficiently atypical, not only to be confusing in diagnosis, but to be entirely misleading. The frequency with which the gall-bladder or the appendix or both have been removed for symptoms that have been produced by primary disease of the urinary tract emphasizes the necessity of urologic investigation if there is doubt regarding the accuracy of the diagnosis. If there are subjective data referable to the urinary tract, or if blood and pus cells are found in the urine, the urinary tract should be regarded with suspicion, until, by subsequent investigation, such suspicion is proved well founded or may be dispelled. The presence of pus or blood or both in the urine may be the result of disease in any part of the urinary tract, and it is noteworthy that at times such are the only data that may lead to investigation of the urinary tract and to the discovery of a pathologic condition, which has remained silent so far as subjective symptoms are concerned.

*Lithiasis.*—Lithiasis is the most common surgical lesion in the kidney. During recent years, approximately 50 per cent. of the operations performed on the kidney at The Mayo Clinic have been for lithiasis. The incidence has perhaps been no greater than formerly, but the careful clinical examina-

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tion of patients, and the investigation of symptoms and objective data, have led to the discovery and diagnosis of lithiasis much more frequently in recent years.

As yet no clear conception of the etiology of lithiasis has been presented, but clinical and experimental investigation has resulted in the exposition of certain significant factors. The theory that remote foci of infection are instrumental in the development of lithiasis has received much support. Considerable evidence has accumulated tending to indicate that perhaps chemical changes incident to the advent of bacterial invasion of the kidney and urine may be instrumental in the precipitation and agglutination of the normal constituents of urine, the oxalates, urates, and phosphates, the most common constituents of calculi. Rosenow has shown that certain strains of bacteria possess definite specificity, and clinical observation has shown that the elimination of active foci of infection has usually resulted in the cessation of the process of recurrent formation of stones in patients who possess a so-called stone-forming kidney. At any rate, and whatever all the factors involved may be, experience has shown that treatment of patients with renal lithiasis is incomplete without the investigation and elimination of all remote foci of infection.

Braasch has presented data to show that stones in the kidney are multiple in more than 40 per cent. of the cases, and that they are bilateral in approximately 10 per cent. At times, stones in the kidney are associated with stones in one or the other or both ureters, which contributes materially to the difficulties of determining proper methods of treatment. Various combinations, such as unilateral renal lithiasis, with ureteral lithiasis of the same side, unilateral renal lithiasis with bilateral ureteral lithiasis, bilateral renal lithiasis with unilateral ureteral lithiasis, and most infrequently, bilateral renal and ureteral lithiasis are encountered. Ureteral stones are associated, however, in less than 5 per cent. of cases of renal lithiasis.

The complications of infection, urinary obstruction, and destruction of renal function provide problems in the treatment of renal lithiasis not always easy of solution. Renal stones may not produce symptoms, and these have been referred to as silent stones. It is true that they may be silent so far as the production of symptoms is concerned, but seldom, if ever, are stones silent so far as their effect on the kidney is concerned. In the presence of calculi there is always some infection in the kidney which varies in degree from the intermittent presence of a few pus cells in the urine to the extreme degree of extensive pyonephrosis with complete destruction of all function. Reduction of function, as determined by the differential functional tests, is often observed in the presence of lithiasis, and many times the functional tests provide a reading so low that it is out of all proportion to the amount of actual injury to renal tissue, which may be misleading. Many cases have been observed in which the differential functional tests showed such marked reduction of function in the presence of lithiasis that one would be led to suspect considerable injury to the kidney; however, at operation a fairly sound



kidney has been found, which subsequent to operation has returned to normal function, at least so far as the functional tests are concerned. It has been suggested that perhaps, through the sympathetic nervous system, stones may influence partial inhibition of renal activity. At any rate, whatever the factors may be, a small return of the dye in a differential functional test, in the presence of lithiasis, should not always abruptly lead to the conclusion that the kidney is as badly injured as the low functional test might indicate.

The significance of the complications of infection, urinary obstruction, and destruction of renal function, is emphasized by the frequency with which the radical operation of nephrectomy is necessary in treating renal lithiasis. In a recent review of 941 cases of renal lithiasis in which operation was performed at The Mayo Clinic during the years 1922 to 1928 inclusive, I found that nephrectomy was necessary in 334 cases (35 per cent.) on account of the degree of infection and destruction of renal tissue. Such a high incidence of nephrectomy reflects unfavorably on conservative non-operative methods.

The question often arises as to which renal stones are of surgical significance and when operation should be done. I believe that with an occasional exception, and in the absence of contraindications, that in practically all instances renal stones should be removed as soon as their presence is known. Furthermore, in the interest of conservatism and preservation of kidneys, it is most important to recognize the presence of renal lithiasis earlier than in the past, to facilitate the conservative removal of stones before such extensive injury has occurred as to make nephrectomy necessary.

It is true that small renal stones will pass, and many do pass. Practically all ureteral stones have originated in the kidney. One may not safely use the size of stones encountered in the ureter as a guide in determining whether or not a renal stone will pass. Many stones leave the kidney to make their passage satisfactorily to the bladder, but these must necessarily be small. Stones may pass from the kidney and become impacted only when they reach the ureterovesical juncture, where in many instances they may be aided in passage by non-surgical methods. In general, so far as size is concerned, it may be stated that if a renal calculus found in the course of a clinical examination, has not produced subjective symptoms, and is less than approximately 0.5 centimetre in diameter, its removal is not particularly urgent. An opportunity should be afforded for spontaneous passage. If, after observation for a period of weeks or months, the position does not change, but the size increases, it is most conservative to consider early removal. On the other hand, repeated renal colic from a calculus of any size retaining its position in the kidney furnishes sufficient and just indication for removal. A renal calculus in the aged, which is and has been silent so far as symptoms are concerned, and when good renal function has been maintained, furnishes another exception to the rule that renal calculi should be surgically removed when the diagnosis is established. In such instances, the mere presence of a stone manifests little, if any, influence on life expectancy, and operation is best postponed until indications for removal occur.

Considerable difference of opinion has existed regarding the branched stone, particularly when it is encountered in the absence of symptoms, and there is minimal infection, and little, if any, reduction of function. In the past, under just such circumstances, there has been a strong justifiable tendency toward observation and postponement of surgical procedures until indications for removal have developed. This has been especially logical when large branched stones have been bilateral. In the past, large branched stones have been removed with great difficulty and with such extensive mutilation of the kidney as to require either primary or subsequent nephrectomy. In recent years some progress has been made in conservative removal by the process of crushing the stone *in situ* before removing it piecemeal through the renal pelvis. If branched stones are causing symptoms, and their presence is resulting in injury to the kidney, the question of conservative removal or nephrectomy is not always easily decided. In the presence of adequate renal function, conservative removal of the stone is the procedure of choice. Nephrectomy certainly is easier than the conservative operation in cases of large branched stones; however, conservation of renal tissue under difficulties distinguishes the work of the surgeon from that of the "operator."

When ureteral lithiasis is associated with renal lithiasis it is not always possible to determine the status of the kidney, as regards the amount of infection and its function, previous to removal of the ureteral calculus, particularly if the ureter is impassable to a catheter. In such instances, it has proved best to remove the ureteral calculus first, if it has been situated in the lower half of the ureter, and determine the renal function and degree of infection later. If a ureteral calculus is situated in the upper half of the ureter it may be removed simultaneously with the stone or stones from the kidney through a posterior incision, if a conservative operation can be accomplished, or simultaneously with nephrectomy, if the indications are clear for the radical operation. In case of the latter necessity, nephroureterectomy to just below the ureteral stone has proved the procedure of choice.

Bilaterality of renal lithiasis is serious in direct proportion to the amount of renal injury and infection. Except under most unusual circumstances, it has not been advisable to operate on both kidneys simultaneously, but, everything else being equal, it has been best to operate on that side first to which the acute symptoms, if any, have been referable. In the absence of acute symptoms, but with difference in function of the two kidneys, it has seemed best to operate first on the kidney with the better function.

In my experience with the conservative operations for removal of stones from the kidney it has been possible to remove stones by pelviolithotomy in 85 per cent. of the cases. The operation of nephrolithotomy, or incision through the cortex of the kidney, has been reserved for cases in which the stones were inaccessible through the pelvis, in that they were encysted in the terminal calices and were situated rather superficially under the renal capsule.

It is noteworthy that the mortality rate is somewhat greater when con-

servative non-operative methods, or late recognition of the presence of lithiasis, have allowed infection and reduction of function to proceed to the extent that nephrectomy is necessary, than when the conservative operations of pelviolithotomy or nephrolithotomy may be employed. In the series of 941 cases of lithiasis there were fifteen deaths, a mortality rate of 1.6 per cent. The mortality rate in 607 cases in which the conservative operations were employed was 1.3 per cent. as opposed to 2.1 per cent. in the cases in which nephrectomy was necessary.

Reformation of renal calculi after conservative operation occurs through the persistence of preëxisting foci of infection and other indeterminate factors entering into the formation of stones. There are so-called stone-forming kidneys in which calculi continue to develop even after all demonstrable foci of infection have been eliminated. However, true reformation of stones occurs rather infrequently, and experience has shown that the relatively high incidence of so-called reformation of stones has in reality been the continued development of stones overlooked at the time of operation, or of particles that were not removed, and which served as nuclei for subsequent stones. Surgeons of wide experience, in operating for renal lithiasis, have all suffered the humiliation of being unable to find enough stones at operation to account for all the shadows in the röntgenogram, and of having shadows persist after operation. Likewise, shadows often have been found immediately after operation, when the surgeon was certain that he had removed all stones completely. In other words, the oversight of one or more stones at operation, or their incomplete removal, is a most significant factor in the reformation of stones. Röntgen-ray examination, in all cases, a few days after operation is the only means of distinguishing between stones that have been overlooked and true subsequent recurrence.

You are all familiar with the method of fluoroscopic examination of the kidney at operation as devised by Braasch and Carman. This procedure has been employed at The Mayo Clinic for a number of years, most advantageously, as an aid to the surgeon in localizing single or multiple stones which otherwise could not have been found, and has provided relative assurance that the kidney is clear of stones at the conclusion of the operation. Although the procedure is not infallible, it is noteworthy that the post-operative röntgenogram seldom depicts a persisting shadow in the region of the kidney when the kidney was found to be clear on fluoroscopic examination at the conclusion of the operation.

Quinby has advocated the making and developing of films at operation as an aid in the localization of stones, and for the assurance of complete removal of all stones. These methods have attained such significance in the surgery of renal lithiasis, that to insure the best results, it is questionable whether one is justified in contemplating pelviolithotomy, particularly for multiple stones, without fluoroscopic aid or without facilities for the rapid development of films at operation.

*Renal Tuberculosis.*—The upper part of the urinary tract seldom is alone

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the site of tuberculosis, and primary tuberculosis of the urinary tract seldom, if ever, occurs. It is generally accepted that tuberculosis of any part of the genito-urinary tract is hæmatogenous in origin. The high incidence of pulmonary tuberculosis in general necropsy records would seem to indicate that the lungs act as the primary focus for secondary dissemination through the blood stream. In fully 80 per cent. of the cases of renal tuberculosis there is associated tuberculosis elsewhere; however, in the absence of contraindications or of activity of a major tuberculous lesion elsewhere, associated lesions should not necessarily deprive the patient of the benefit to be obtained from removal of the major tuberculous lesion if it is in one kidney. Although heliotherapy and nonsurgical methods of treatment have been advocated, and unquestionably possess some merit, the cure of unilateral renal tuberculosis is usually not accomplished except by nephrectomy.

As regards the diagnosis, it may be stated that the clinical recognition of renal tuberculosis has reached a high state of accuracy, although there is considerable difference of opinion regarding the relative merits of certain data on which the diagnosis may be based. Wildbolz, Braasch, Thomas, Medlar and others have called attention to the difficulty encountered in the proper interpretation of the presence of the bacilli of tuberculosis in the renal secretion, the one bit of evidence which has been accepted as most conclusive that renal tuberculosis exists in the kidney from which such secretion has been obtained.

Wildbolz stated that the demonstration of bacilli of tuberculosis in the renal secretion by no means signifies that the corresponding kidney is the seat of specific tuberculous tissue changes and that the presence of bacilli in the renal secretion may be due to so-called bacilluria, especially in patients with advanced pulmonary lesions, without there being any tuberculous changes in the kidney. Medlar and others are of the opinion that bacilluria is evidence of tuberculous disease in the kidney. Thomas stated that never has he removed a kidney which eliminated bacilli of tuberculosis that did not contain a lesion of tuberculosis. These opposing opinions are presented to show cause for the wide variation in the incidence of bilateral renal tuberculosis. Wildbolz reported bilaterality in 12 per cent. of his cases, whereas Thomas reported bilaterality in 55 per cent., stating that inasmuch as all renal infections in which bacilli of tuberculosis are present are hæmatogenous in origin, both kidneys are infected equally and that bilateral infection is the rule.

In an effort to determine the incidence of bilaterality of renal tuberculosis at The Mayo Clinic, I recently reviewed the operative and non-operative cases that have come under observation during the ten-year period from January 1, 1919, to January 1, 1929. During this time nephrectomy was done in 574 cases and 264 non-operative cases were observed. In this latter group the diagnosis of renal tuberculosis was definitely established and all of the cases were considered non-surgical, with the exception of forty-three in which nephrectomy was advised but was not accepted by the patient. In other words, approximately 73 per cent. of the cases of renal tuberculosis

were regarded as suitable for nephrectomy. The remaining 221 cases were considered non-surgical because of bilaterality in seventy-seven, occlusion and relative freedom from symptoms in forty-eight, active and advanced pulmonary tuberculosis in thirty-seven, and extensive and advanced tuberculosis elsewhere, local or generalized, in thirty-eight. In ten cases, in which nephrectomy had been performed for tuberculosis of one kidney, tuberculosis of the remaining kidney was found; in four non-operative cases, bilateral renal tuberculosis was proved at necropsy. The remaining seven cases were considered non-surgical on account of associated malignant or serious non-tuberculous constitutional disease. The diagnosis of bilaterality in the seventy-seven cases was definitely established in most instances through the presence of bacilli of tuberculosis in the secretion from both kidneys, or through inoculation of guinea pigs. Definite evidence of bilateral renal tuberculosis existed in ninety-one of the non-operative cases. Among those cases in which nephrectomy was done, evidence of bilaterality existed in twenty and included those cases studied by Braasch and Morse. The diagnosis of bilaterality in these cases was established either from the finding of bacilli of tuberculosis in the secretion from both kidneys, previous to, or subsequent to, operation or from the positive findings from both sides, obtained through inoculation previous to, or subsequent to, operation. In other words conclusive evidence of bilaterality existed in 111 of the entire series of 838 operative and non-operative cases, an incidence of 13 per cent., which I am confident expresses a liberal incidence of bilaterality in the series.

Nephrectomy in the presence of bilateral renal tuberculosis is seldom indicated or justifiable; however, it may occasionally be considered if there is much pain, hæmaturia, or acute sepsis in one kidney and if the other side is but slightly involved. It may be considered also when, after prolonged observation, bilaterality of the condition becomes questionable. An example is that of a patient who came to The Mayo Clinic in July, 1923, at which time the guinea-pig test was positive for tuberculosis in both kidneys, and non-surgical measures were instituted. The patient returned in April, 1926, in good condition, and a diagnosis of unilateral involvement only was made and right nephrectomy was done. One year later the patient was again carefully examined and no evidence of tuberculosis of the urinary tract was to be found.

As to whether or not nephrectomy should be considered in the presence of tuberculous lesions elsewhere depends largely on the degree of activity of the various tuberculous lesions. Certainly, in the absence of general contraindications, if the tuberculous kidney is the most important tuberculous lesion, its removal is justly indicated. The low primary mortality rate following nephrectomy for unilateral renal tuberculosis justifies the operation even if there is moderate pulmonary involvement. There were fourteen deaths, a mortality rate of 2.4 per cent., in the series of 574 cases in which nephrectomy was done for renal tuberculosis; however, in the last 357 of these there were but seven deaths, a mortality of 1.9 per cent. In general, there has been a

late mortality of 20 per cent. within five years, with partial recovery in 80 per cent. of the patients; 60 per cent. have been completely cured, and 20 per cent. have had persisting vesical symptoms. The shorter the duration of the disease and the less extensive the renal involvement and cystitis, the better the result. Braasch recently reviewed sixty-five cases in which nephrectomy was done between five and fifteen years ago and in which advanced secondary ulcerative cystitis was present with markedly reduced capacity of the bladder. Among these, there was a five-year mortality of 37 per cent. The condition of the bladder in 30 per cent. of patients who were living was not improved. Early nephrectomy, before advanced involvement of the bladder occurs, insures materially better results than may be expected in those cases of advanced involvement of the genito-urinary tract.

Indolent healing of the wound and a temporarily persisting sinus usually is due to perinephritic involvement, incomplete removal of diseased tissue, persisting infection of the ureter, and the institution of drainage. Thorough removal of perirenal fat, accurate hæmostasis, partial ureterectomy, as low as possible, through the primary incision, with sterilization by cautery of the stump after secure ligation, afford closure of nephrectomy wounds without drainage and result in primary healing in a high percentage of cases.

*Neoplastic Disease.*—In the consideration of malignant disease of the kidney it is most essential that diagnosis be made early to insure the best results. Unfortunately, extensive advancement often occurs silently, so far as subjective symptoms are concerned, an operability frequently is questionable. Most malignant lesions of the kidney tend to metastasize rapidly, through local extension, to perirenal structures and the renal vein, which provides direct avenues for remote metastasis. In the absence of demonstrable metastasis and fixation of the kidney by direct extension to surrounding structures, nephrectomy affords the best prognosis. The anterior transperitoneal route facilitates removal of large tumors entirely inaccessible through the usual posterior incision.

Within the last year, Hager and I reported a statistical review of 271 cases of malignant neoplasm in which the various types of tumors, methods of treatment, and results, were presented. My reason for including at this time any consideration of neoplastic disease of the kidneys is to emphasize the necessity of pre-operative recognition or identification at operation of papillary epithelioma of the renal pelvis, which usually is a lesion of a relatively low degree of malignancy and differs from all other neoplasms of the kidney in its manner of extension and advancement and in which simple nephrectomy does not suffice. Papillary epithelioma of the renal pelvis progresses, not by invasion of parenchyma and surrounding structures, but by extension along the mucous membrane of the pelvis to the calices, and along the ureter to the bladder. In the past, unless the bladder has been involved, the surgical procedures have been limited usually to nephrectomy, with subsequent recurrence of hæmaturia, indicating subsequent ureterectomy. Some time ago I reviewed the cases of papillary epithelioma of the renal pelvis observed at

The Mayo Clinic; in two-thirds of the cases the bladder was involved at the time of examination, or it became involved after nephrectomy or after nephrectomy and partial ureterectomy. The high incidence of metastasis to the portion of the bladder immediately surrounding the ureteral orifice, or immediately adjacent to it, emphasizes the necessity of segmental resection of the bladder with the inclusion of the intramural portion of the ureter and the adjacent area simultaneously with nephro-ureterectomy.

Much might be said in the consideration of malignant lesions of the kidney, however, I would emphasize that an operable tumor of the kidney, in the absence of contraindications always is a surgical condition and that good results are dependent on early diagnosis and early operation.

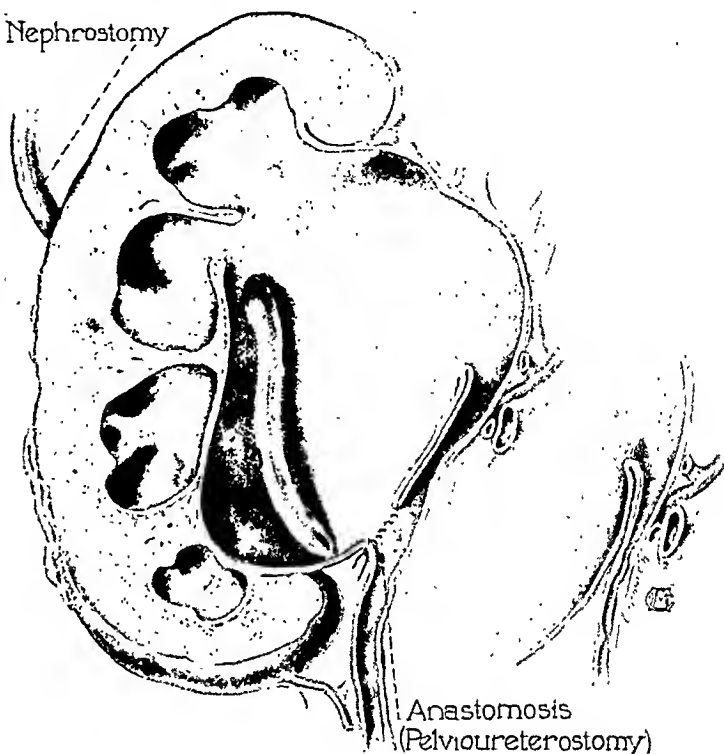
# URETEROPYELONEPHROSTOMY FOR URINARY OBSTRUCTION AT THE URETERO PELVIC JUNCTION\*

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URETEROPYELONEPHROSTOMY, or the anastomosis of the pelvis of the kidney, and the ureter, may be followed by highly satisfactory results. Reviews of literature of plastic operations on the renal pelvis and ureter have been made by Adrian and Lichtenberg,<sup>1</sup> Kroiss,<sup>3</sup> Weinberg,<sup>6</sup> and Loux.<sup>4</sup> Weinberg performed ureterorrhaphy successfully for stricture and stone in a case of solitary kidney. One of the most interesting cases of this type was reported by Bazy.<sup>2</sup> The patient was a boy, ten years of age, on whom Bazy performed ureteropyelonephrostomy in 1904. Six years later, examination revealed the anastomosis to be functioning satisfactorily.



A review of the literature on ureteropyelonephrostomy leads one to believe that if the anastomosis is correctly made, it will function satisfactorily. In the two cases reported here the anastomosis was successful.

CASE REPORTS.—CASE I.—A man, thirty-five years of age, had had left nephrectomy for stone elsewhere. In 1926, he had begun to have attacks of intermittent renal colic, with distention of the right kidney. Intermittent ureteral catheterization had been necessary. In August, 1928, prior to admission, he had suffered a similar attack, but removal of the catheter from the right renal pelvis had been followed by recurrence of symptoms, and urine did not drain from the kidney. With the ureteral catheter in the kidney, the excretion of phenolsulphonephthalein was 40 per cent. in two hours. August 15, cystoscopic examination revealed a single right hydronephrotic kidney, with a capacity of at least 150 cubic centimetres. Pus in the urine was graded 1.

The blood urea varied from 28 to 40 milligrams in each 100 cubic centimetres. August 15, 1928, ureteropyelonephrostomy was performed. Anastomosis was made between the ureter and pelvis at the most dependent portion of the pelvis. The kidney was hugely

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hypertrophied and the pelvis was greatly distended. Obstruction at the ureteropelvic juncture was caused by pressure on the renal pedicle. Nephrostomy was done simultaneously to remove tension from the anastomosis. (Fig. 1.) Fifteen days after the operation the wound was healed and from 2000 to 3000 cubic centimetres of urine was passed from the urethra daily. The patient gained in weight and his general condition was excellent. In May, 1929, the patient reported his condition to be excellent, except for the fact that he found it necessary to lie down once or twice a day in order completely to empty the kidney.

Cystoscopic examination, June 10, revealed retention of 30 cubic centimetres of slightly turbid urine in the right renal pelvis. Indigocarmine appeared in the urine eight minutes after intravenous injection and was excreted in normal quantity. A No. 10 Garceau catheter slipped easily into the renal pelvis. Blood urea was estimated at 38

milligrams in each 100 cubic centimetres. Ptosis of the right kidney led to the belief that it was producing some angulation of the anastomosis when the patient was in the upright position, and nephropexy was done, June 26. July 3 he was out of bed and the kidney was emptying completely.

CASE II.—A man, twenty-four years of age, had undergone operation elsewhere for removal of a calculus from the pelvis of the right kidney in March, 1928. Post-operative obstruction at the ureteropelvic junction had occurred, producing attacks of pain in the right renal region.

Cystoscopic and pyelographic examination, March 15, 1929, showed the right ureter occluded at the ureteropelvic junction. From the right kidney, however, some



FIG. 2.—Case II. Pre-operative pyelogram showing obstruction at ureteropelvic junction.

urine was draining which contained pus, graded 3. An attempted pyelogram of the right kidney showed that the opaque substance did not enter the pelvis. (Fig. 2.) Excretion of phenolsulphonephthalein from the right kidney was estimated as a faint trace and that from the left kidney as 10 per cent. The return of indigocarmine from the right kidney was graded 3 and that from the left kidney, 4. The left kidney was normal.

Operation was performed, April 2, 1929. Obstruction from a dense scar was found at the right ureteropelvic junction. Ureteropyelonephrostomy and nephrostomy were performed. (Fig. 3.)

The post-operative course was uneventful. Post-operative cystoscopic and pyelographic examination, June 12, 1929, showed good urinary drainage from the right kidney. The urine was practically normal. Indigocarmine from the right kidney was graded 2 and that from the left kidney, 4. The anastomosis was patent and well shown in the pyelogram. (Fig. 4.) There was dilatation of the pelvis and upper calix. The general condition of the patient was excellent at the time of his dismissal, June 28.

# URETEROPYELONEPHROSTOMY FOR URINARY OBSTRUCTION

## TECHNIC OF URETEROPYELONEPHROSTOMY

In the two cases reported here, lateral anastomosis was made between the ureter and the dependent portion of the hydronephrotic renal pelvis. (Fig. 1.) A ureteral catheter was used temporarily through the anastomosis to serve as a scaffolding for healing.

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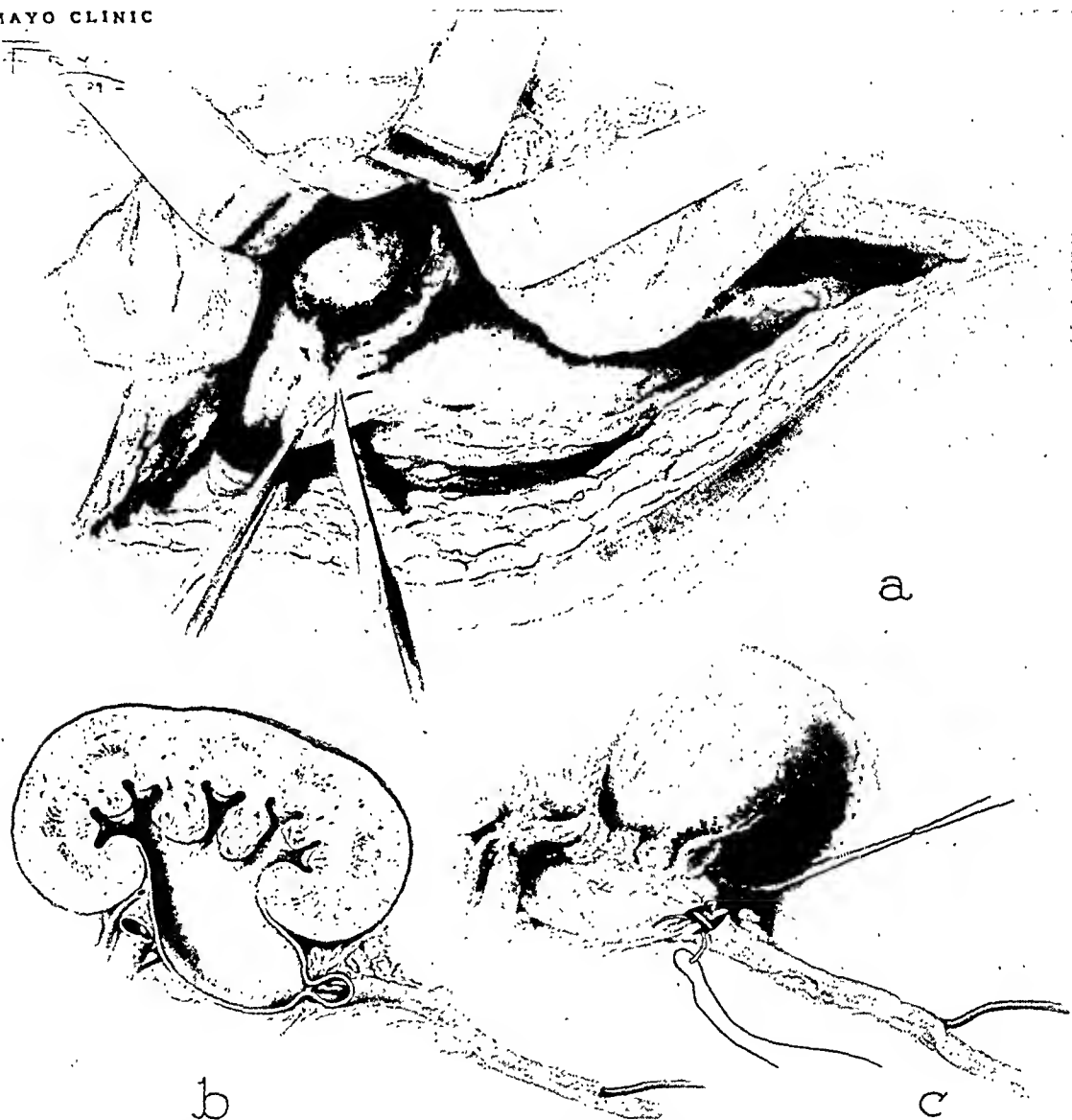


FIG. 3.—Case II. *a*, Freeing of scar tissue causing angulation of the ureter below true obstruction; *b*, true obstruction at the ureteropelvic junction found by using ureteral catheter as probe; *c*, lateral anastomosis (ureteropyelonephrostomy).

In the first case the catheter had been inserted in the ureter in order to decompress the renal pelvis and was there at the time of operation. It was carried into the pelvis through the anastomosis and maintained in place for twenty days, when it was removed. In this case also temporary nephrostomy was done to prevent tension on the anastomosis, a number 14 French catheter being used. The catheter was removed on the eighth day.

In the second case, the cause of the obstruction was a dense scar of

fibrous tissue at the ureteropelvic juncture. Connective tissue had extended to a point below this, angulating the ureter as shown in figure 3, *a*. When first exposed this angulation appeared to be the site of obstruction. After it was free, however, an opening was made in the ureter about 3 centimetre



FIG. 4.—Case II. Post-operative pyelogram following ureteropyelonephrostomy showing anastomosis patent.

remained for thirteen days. A nephrostomy tube was also used and removed on the tenth day after operation.

distal to this point and a catheter was pushed toward the renal pelvis as a probe. It was then found that the obstruction had not been relieved but existed at the ureteropelvic juncture. (Fig. 3, *b*.) Dissecting up the ureter to this point, the obstruction was found and a lateral anastomosis was made between the ureter below and the pelvis above. (Fig. 3, *b* and *c*.) Two rows of chromic catgut were used in both cases in making the anastomosis. (Fig. 3, *c*.) A ureteral catheter was carried through the anastomosis and out of the incision through the ureterostomy opening. It

#### SUMMARY

The value of plastic procedures on the kidney, pelvis and ureter from which the urinary outflow is obstructed is emphasized in these two cases of ureteropyelonephrostomy, in one of which the operation was one of necessity and was life-saving, in view of the fact that the obstruction at the ureteropelvic juncture was complete and the kidney was solitary. Infection in the kidney operated on does not seem to complicate surgical results, as may be noted in Case II. Subsequent to operation the degree of infection of the kidneys is diminished and the function of the kidney improved. Additional cases of heminephrectomy, as well as resections of the hydronephrotic renal pelvis reported elsewhere,<sup>5</sup> further tend to bear out these conclusions.

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# TUBERCULOSIS OF THE PROSTATE GLAND \*

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TUBERCULOSIS of the prostate is a frequent accompaniment of genital tuberculosis and does not occur so often in urinary tuberculosis. In fact the great wonder is that the prostate is not involved in 100 per cent. of the cases of genito-urinary tuberculosis, occupying as it does a prominent position at the junction of the urinary and genital tracts. It is indeed strange that the prostatic duct orifices, numbering over 60 on the average, may be constantly bathed in tuberculous urine for years and in at least 30 per cent. of the cases escape any tuberculous infection that is appreciable by the palpating finger.

Our interest in this type of case was aroused first by an operation done many years ago by Dr. David W. MacKenzie, at Bellevue Hospital, at which a prostate suspected of having a carcinomatous nodule was found to have a tuberculous calcified area apparently primary although the patient was a colored man and the members of his race are noted for the frequency with which tuberculosis occurs.

Another case suffering from tuberculosis of the prostate and membranous urethra with a so-called watering pot perineum was operated upon several times and finally all of the little sinuses healed thoroughly and in a spectacular manner when the patient was subjected to Alpine light treatment.

We were under the impression that we had found two cases of primary tuberculosis of the prostate but intensive study caused us to doubt that the evidence at hand was entirely conclusive so are obliged to present these cases as secondary to some other lesion in the body.

Tuberculosis seems to affect the epididymes most often of all the genito-urinary organs. The kidney is probably next in frequency of attack followed in close order by the ureters and bladder. The seminal vesicles are occasionally the site of tuberculosis, usually following a long-standing tuberculous epididymitis, and the prostate is least often affected and primary tuberculosis of the prostate is extremely rare.

A little over two per cent. of pulmonary tuberculous cases show, at autopsy, tuberculosis of the genito-urinary tract. Saxtoff of Copenhagen reports 547 cases of urogenital tuberculosis in 10,016 autopsies. Cornet, reviewing the records of 10,000 autopsies found that, excluding pulmonary tuberculosis, less than 100 were urogenital. Kapsammer records about 200 cases of urogenital tuberculosis from 20,700 post-mortem examinations. Hesse states that 232 cases of tuberculosis of the genito-urinary tract were discovered in a series of 10,864 autopsies and Krzywicki twenty-five in 500.

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\* Read before The Western Urological Association, July 5, 1929.

## TUBERCULOSIS OF THE PROSTATE GLAND

Seventy per cent. of the cases of urogenital tuberculosis demonstrate coincident tuberculosis of the prostate and a very small fraction of 1 per cent. primary tuberculosis of the gland. Krzywicki discovered in fifteen cases of urogenital tuberculosis that the prostate was tuberculous in fourteen. Hesse in his review of 15 cases found 554 with prostatic tuberculosis. Barney and Cabot found it in seventy-five out of 101 cases. Oppenheim reports thirty-seven cases of urogenital tuberculosis in eighteen of which a tuberculous prostate was also discovered. Collenet reports forty-four cases of prostatic tuberculosis in seventy patients with tuberculosis elsewhere in the urogenital tract. Halle and Motz demonstrated fifty-nine cases of tuberculous prostatitis in a series of seventy-two and Simmonds twenty-six in his report of thirty-five cases of urogenital tuberculosis.

The proportion of pulmonary tuberculous cases which show at autopsy tuberculosis of the genito-urinary tract, is demonstrated in Table A, which gives the percentage of urogenital tuberculosis in about 52,000 autopsies.

TABLE A

Reported by	Autopsies	Urogenital Tuberculosis
Kapsammer:.....	20,700	200
Collenet.....	10,000	100
Saxtoff.....	10,016	547
Hesse.....	10,864	232
Krzywicki.....	500	25
	52,070	1,104—2.1%

Tuberculosis of the prostate in itself is not common but it is present in about 70 per cent. of the cases of urogenital tuberculosis. Table B clearly illustrates this fact.

TABLE B

Reported by	Urogenital Tuberculosis	Prostatic Tuberculosis
Krzywicki.....	15	14
Hesse.....	815	554
Barney, Cabot.....	101	75
Oppenheim.....	37	18
Collenet.....	70	44
Halle, Motz.....	72	59
Simmonds.....	35	26
	1,145	790—68.9%

Thus it is clear that when tuberculosis of the urogenital tract is discovered despite the fact there may be no symptoms of prostatic involvement, a most careful examination of this gland should be made in order that the immediate and future treatment be appropriate and the prognosis appreciated.

TABLE C

Reported by	Prostatic Tuberculosis	Pulmonary Tuberculosis
Desnos.....	16	6
Julien.....	41	23
Krzywicki.....	14	12
Oppenheim.....	100	81
Rautbard.....	100	85
Reclus.....	100	98
Young.....	342	96
Socin.....	52	41
	765	442—57%

Having reviewed the literature very carefully we have been able to find but one case in which tuberculosis of the prostate was undeniably primary. This case was reported by Crandon with complete autopsy and pathological reports. Barney and Koll each report a case which may have been one of primary tuberculosis of the prostate but there was no Röntgenological examination of the chest reported in either case. Such an examination either fluoroscopically or film, is necessary in conjunction with physical examination to rule out the presence of old or quiescent pulmonary lesions. Koll states that his patient had no reaction to large doses of tuberculin. This fact is good circumstantial evidence but not conclusive. Salleras describes a case of primary tuberculosis of the prostate and his report is quite convincing. He reports negative X-ray and cystoscopic examinations but according to present-day laboratory standards his report is not complete.

Whether the prostate is the site of primary tuberculous infection is of academic interest only and, because it is so extremely unusual, of practically no surgical importance.

The diagnosis of tuberculosis of the prostate is difficult. It is especially so when it occurs, as it occasionally does, in conjunction with benign adenomatous hypertrophy or when in a patient of cancer age, hard nodules are discovered on digital examination. Nevertheless if we remember that in all cases of urogenital tuberculosis the prostate is involved in 70 per cent., earlier diagnoses can be made and the chance for cure or lengthening of life proportionately increased.

The cases which we have collected number twenty-three and of these it was thought that two were probably primary lesions in the prostate but a thorough examination of the patients cast some doubt on the cases being primary in the prostate gland.

The cases collected are shown in detail in the accompanying chart:

By an examination of this chart it will be seen that tuberculous involvement of the prostate gland is a disease of young adult life, our cases varying in age from twenty-four to sixty-nine, the average being thirty-two years.

Among these twenty-five cases there were sixteen patients with tuberculosis of the epididymes, two of which at operation had severe involvement of

# TUBERCULOSIS OF THE PROSTATE GLAND

Name and No.	Age	Diagnosis and method of investigation	Operative	Non-operative diet, rest, fresh air, Alpine light	Tuberculin	Results					Remarks
						Cured	Im-proved	Unim-proved	Dead		
1. S. L., No. 275965	26	T.B. bladder, lungs, kidneys	None—cystoscoped	Our regular routine	None				Yes		Rectal examination reveals a large mass which is typical of T.B. prostate.
2. P. M., No. 269458	25	Nephrectomy (R), partial ureterectomy		Lamp treatment	None		Yes				Rectal examination reveals a large mass which is typical of T.B. prostate. Sent to convalescence home.
3. J. L., No. 267216, 270006	24	T.B. epididymis (R), T.B. vas deferens (R), T.B. S. vesiculectomy, T.B. perineum	Epididymectomy, partial vasectomy, S. vesiculectomy, resection of wound	Lamp treatment	Yes		Yes				Enlarged boggy prostate typical of T.B.
4. A. J., No. 262824	33	T.B. epididymitis, abscess spermatic cord	Epididymectomy (L), drainage of abscess	Lamp treatment	None		Yes				Gained weight. Much improved. Prostate much enlarged.
5. H. H., No. 285159	30	T.B. epididymis	Epididymectomy, bilateral	Lamp treatment	None		Yes				Large indurated prostate; seminal vesicles nodular.
6. A. T., No. 284718	28	T.B. epididymis	Epididymectomy, bilateral	Lamp treatment	None		Yes				Had eye-ball removed for T.B. Has T.B. of spine. Enlarged and indurated prostate.
7. E. O'D., No. 280179	25	T.B. epididymis (L), T.B. prostate and S. vesicles	Epididymectomy (L)	Lamp treatment	None						Enlarged and boggy prostate.
8. A. M., No. 275381	29	T.B. kidney (R), T.B. lungs	Nephrectomy (R)	Lamp, diet, hygienic	Yes		Yes				Prostate twice usual size. Very firm in consistency.
9. J. P., No. 285471	49	T.B. epididymis (L), pulmonary T.B.	Epididymectomy (L)	Lamp, diet, hygienic	Yes						Enlarged and boggy prostate.
10. E. G., No. 274641	30	T.B. kidney (R), T.B. epididymis	Nephrectomy (R)	Lamp, diet, hygienic	Yes						Has had pain in epididymis and has been receiving light treatment for same. Prostate enlarged and harder than normal in consistency.
11. C. F., No. 280486	15	T.B. epididymis (L)	Epididymectomy (L)	Lamp, diet, hygienic	Yes		Yes				Has an enlarged boggy prostate. Left vasa deferentia thickened and beaded.
12. P. E., No. 279744	41	T.B. epididymis (R)	Epididymectomy (R)	Lamp, diet, hygienic	Yes						Had orchidectomy two years ago for T.B. Prostate is enlarged and boggy. Seminal vesicle enlarged and tender.
13. F. DeC., No. 268306	38	T.B. kidney and ureter (R), epididymectomy	Nephrectomy and ureterectomy (R), epididymectomy	Lamp, diet, hygienic	Yes						Prostate enlarged and harder than normal.



Name and No.	Age	Diagnosis and method of investigation	Operative	Non-operative diet, rest, fresh air, Alpine light	Tuberculin	Results				Remarks
						Cured	Improved	Unimproved	Dead	
14. G. McN., No. 267444	69	Enlarged prostate operation	Two-stage prostatectomy	Diet	None		Yes			Sent to Sea View for after treatment.
15. S. G., No. 276016	53	Stones in prostate	Two-stage prostatectomy	Diet, Alpine light	None			Yes		Died at home 3 weeks after leaving
16. S. E., No. 241122	31	T.B. prostate	None	Rectal examination on this patient showed a typical T.B. prostate	None					Patient had T.B. of seminal vesicles and epididymes. Was not in condition for any kind of surgical intervention. Sent to the country.
17. Nos. 242056 249033 250609	28	T.B. epididymes, T.B. vesicles. Prostate on examination is typical of tuberculosis.	Epididymectomy, S. vesiculectomy	None	None					Patient had bilateral epididymectomy. Came back several months later; had a bilateral seminal vesiculectomy. At time of operation the rectum was injured and had a fecal fistula. Unknown whether he had any treatment after he left.
18. G. W., No. 259623	20	T.B. S. vesicles, T.B. testicle	Vesiculectomy, bilateral, unilateral orchidectomy	Alpine light	None		Yes			Had perineal sinus. Prostate normal on examination. To go to country.
19. S. N., No. 254347	40	T.B. s. vesicle (R), vas (R), epididymis (R)	S. vesiculectomy, vasectomy, epididymectomy, all (R)	None	None		Yes			Patient had a typical T.B. prostate.
20. P. V., No. 217736	28	T.B. testicle, T.B. vas and spermatic cord and epididymis	Orchidectomy (this case was on Second Surgical Div.)	None	None		Yes			Returned a year after and had nephrectomy. No rectal done.
21. J. K., No. 255332	23	T.B. scrotum, T.B. vas deferens	Excision for T.B. (L) scrotum (Second Surg. Case)	None	None		Yes			Returned after he had epididymectomy one month ago for T.B. Rectal was negative.
22. A. deS., No. 271442	46	T.B. kidney (L), T.B. prostate, T.B. epididymes	Nephrectomy (L), epididymectomy, bilateral							Has been receiving our complete T.B. treatment, including diet, rest, tuberculin and light treatment. Has gained weight. Is in good condition.
23. No. 273782	25	T.B. epididymis (L), T.B. S. vesicle (L), T.B. prostate	Epididymectomy (L)	Diet, lamp, hygienic	Yes		Yes			Prostate enlarged to twice usual size. Nodular seminal vesicles enlarged.

the testicles. Seven of them had seminal vesiculitis in addition to their tuberculosis of the prostate gland. Kidneys, ureters and bladders were involved in five cases, while unmistakable tuberculosis of the lungs was present in two cases.

The two cases which on ordinary routine examination showed no other gross lesion of tuberculosis were as follows:

#### CASE REPORTS

CASE I.—Male, G. McN., age 69 years, history No. 267444. On admission, June 6, 1926, patient complained of frequent, difficult and painful urination. His past, personal and family histories were of no relative importance. The frequency of urination started about four years prior to admission and grew progressively worse. This gave him very little concern but about a week before he entered the hospital marked difficulty of urination and coincident pain developed. At no time had he noticed blood in his urine, which, he stated, was always very clear. The physical examination was negative save for the prostate which was enlarged three times its normal size and not nodular. There were six ounces of residual urine. A diagnosis of adenomatous hypertrophy of the prostate was made, and on June 8, 1929, a suprapubic cystostomy was performed and the prostate found to practically fill the bladder. On June 18, 1929, a perineal prostatectomy was performed with sacral and parasacral anaesthesia. The prostate was enucleated. This procedure was accomplished with difficulty because of the unusual softness of the gland, which was boggy and full of pus.

Convalescence was slow and despite all effort to close them, sinuses persisted in the abdominal and perineal wounds. Alpine lamp treatment was administered without result. Finally the patient was transferred to another institution and it has not been possible to ascertain the ultimate outcome of the case.

CASE II.—Male, S. G., age 53 years, history No. 276016, was admitted to the hospital December 23, 1928; chief complaints frequency, cloudy and bloody urine. For two years he had been treated intermittently for cystitis and frequency but no prostatic examination had been made nor had he been cystoscoped. His past, personal and family histories were essentially negative. He was emaciated and his prostate was enlarged and nodular. Upon pressure definite crepitus was elicited in these nodules, suggesting the presence of prostatic calculi.

The X-Ray showed the left kidney shadow large and low. Right kidney shadow not clearly made out. In the region behind the symphysis there were several shadows; again led to the inference that there were stones in the prostate. Cystoscopy was attempted but no information of value was gained because there was so much pus and debris that the ureters could not be located.

The patient's general condition improved under treatment and on December 30, 1927, with local anaesthesia, a suprapubic cystostomy was performed and drainage through the abdominal wound established. There was very little prostatic intrusion and no stones were palpable. On January 25, 1929, perineal prostatectomy was performed. The prostate was moderately enlarged and was enucleated with difficulty. It contained a small quantity of pus and some gravel. Several areas of caseation and calcification were noted. Microscopic section of the tissue removed presented the histological features of an advanced tuberculosis. At many places conglomerate tubercles were encountered in an advanced stage of central caseation. In addition sections showed the structure of a fibroadenomatous hypertrophy of the prostate.

*Pathological Report.*—Microscopically the contents of the tube with one piece in it shows fibrous tissue with necrotic areas, one area suggesting early calcification. The other material shows muscular and glandular tissue of prostate-like arrangement in which are found fairly typical tubercles, polygonal cells and somewhat atypical Langhans' cells, also areas of caseous necrosis.

Immediately following the prostatectomy the patient had a severe reaction with high temperature but gradually his condition improved. For a while the improvement continued but a cold abscess developed in the left elbow and in the right wrist. Ultra-violet ray therapy was instituted. A sinus formed in the abdominal wound and also in the perineal wound. The patient's general condition grew progressively worse and he died March 15, 1929.

Often cases that seem to be primary prove, on complete investigation, to be secondary to some remote lesion which has become inactive or arrested. As a matter of fact one cannot be absolutely certain that a case of tuberculosis of the prostate is primarily confined to that structure without an autopsy. Thus it is seen that this diagnosis is a very difficult one to make in an authoritative manner.

Tuberculosis of the prostate is most commonly found associated with acid-fast bacillary infections of the epididymes, vasa deferentia and seminal vesicles. Occasionally the epididymis, vas deferens, seminal vesicle and kidney on one side will be diseased and the other side will be entirely free. In such a case one may find tuberculous nodules and even abscess formation on the corresponding side of the prostate gland and the other side comparatively or entirely free from the disease.

One of the most surprising things in the practice of medicine is the immunity from infection that the prostate enjoys in certain cases suffering, sometimes for many years, from renal tuberculosis, during which time the posterior urethra and prostatic duct orifices are almost constantly bathed in tuberculous urine.

*Operative Treatment.*—Surgery is not ordinarily indicated in tuberculosis of the prostate and, indeed, in most cases in which the tuberculous prostate has been removed the operation was performed due to a mistake in diagnosis, as happened in one of our cases, No. 276016; or the tuberculosis accompanied some other pathological lesion such as case No. 267444, in which the tuberculous lesion occurred in an adenomatous hypertrophy of the prostate gland.

There are very few conditions in which surgical removal of a tuberculous prostate is indicated. Evacuation of a tuberculous abscess is to be avoided when possible, as such a procedure is liable to be followed by sinuses which heal slowly or not at all and may become a source of great annoyance.

*Non-operative Treatment.*—It is our practice to subject cases which have been operated upon as well as those upon whom operation is not done to a continual period of observation and care. In the clinic which we have established for this purpose and in fact for the treatment of all cases of post-operative and inoperable tuberculosis of the organs of the genital and urinary tracts, the patient's temperature is taken and recorded, the weight is observed. Instructions as to diet, exercise, rest, fresh air, sunlight and other hygienic measures are carefully explained and enforced as far as possible. In addition parallel series of cases are being observed, one group of which are given Alpine light or quartz light therapy and the other Koch's Old Tuberculin in graduated doses.

## TUBERCULOSIS OF THE PROSTATE GLAND

Tuberculin has been used by us for more than three years. It is not used alone but it is included in the régime of treatment as an adjunct or subsidiary agent. The régime comprises besides tuberculin, the hygienic, dietetic and rest treatment of tuberculosis, mercury vapor, quartz light therapy, heliotherapy and the indicated urologic treatment. The general plan is to combine the urologic treatment with the treatment of tuberculosis to the extent it is applicable, thus developing a régime of treatment which may be adapted to the needs of the individual patient. Those patients with active pulmonary tuberculosis in addition to their urologic lesions, are not given tuberculin.

The theory upon which tuberculin is given a place in the general plan of treatment is the present-day accepted theory that tuberculin causes an inflammatory focal reaction at the site of the disease and thus promotes fibrosis of the lesion. It is recognized that it is difficult to bring about unharmed focal reactions since the characteristics of the lesions vary so widely, particularly in renal tuberculosis. In the same renal lesion, young tubercles, old tubercles, small uncased tubercles and large pus-filled or fibrotic cavities frequently coëxist. It is evident that the effect of a given amount of tuberculin on the various lesions must vary widely. Therefore it has been deemed best to adhere to the plan of small dosage, relying on the appearance of any evidence of local, focal or constitutional reactions as the guide to the dosage. This method is of course open to criticism on the grounds that focal reactions are not always obtained when there is no subjective or objective evidence of them. However, the method seems to have worked out satisfactorily.

Koch's Old Tuberculin is the only tuberculin used. It was chosen for no particular reason except a somewhat more extensive experience in its use and it has been suggested that it causes more inflammatory changes at the focus of the disease.

Serial doses begun in small amounts are slowly increased until evidence of a local, focal or constitutional reaction occurs, then the dose is reduced and continued with a cautious increase until a reaction again occurs. It is again reduced and continued as before. The usual beginning dose is one-tenth c.c. of a one to ten million dilution of tuberculin. The injections are given subcutaneously.

The serial dilutions of tuberculin are prepared in the following manner which is at least in part widely used. Seven small wide-mouthed, glass-stoppered bottles, a graduated one c.c. glass pipette and a graduated ten c.c. glass pipette are sterilized. In one of the glass bottles one c.c. of Koch's Old Tuberculin is placed. To this is added nine c.c. of the diluent consisting of distilled water to which eight-tenths of one per cent. of sodium chloride and twenty-five-hundredths of one per cent. of phenol have been added and sterilized by autoclave. The bottle is labelled O.T. .1 and for convenience the date of the preparation is also placed on the label. The bottle is shaken vigorously by hand and one c.c. is withdrawn and placed in one of the remaining bottles. To this is added nine c.c. of the diluent and the bottle is labelled O.T. .01. After shaking, one c.c. is then withdrawn from this bottle

and the dilutions are carried on in the same manner through the remainder of the seven bottles. There are then seven bottles labelled as follows: O.T. .1; O.T. .01; O.T. .001; O.T. .0001; O.T. .00001; O.T. .000001; O.T. .0000001. The tuberculin is not designated in milligrams or grams as the above liquid measurements have been found practical for both estimating the individual patient dosage and for record keeping. The dilutions are kept in the refrigerator in the intervals between clinic sessions. Fresh dilutions are made about every two weeks during summer months and monthly during the winter. The diluent has been kept as long as a year with no evident deterioration.

*Results of Treatment.*—Twenty-one of these cases had an operation, only two of which were on the prostate gland. Of the latter, one died a few weeks after leaving the hospital. Another case improved under palliative treatment.

Eight of the cases were given tuberculin after the method practised by Wang and apparently benefited greatly by its administration. None of the patients were harmed by the tuberculin injections.\*

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## TESTICULAR NEOPLASMS

THE RELATION BETWEEN THE PATHOLOGIC HISTOLOGY, CLINICAL COURSE,  
AND REACTION TO IRRADIATION IN TESTICULAR NEOPLASMS

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THE advent of irradiation treatment of testicular neoplasms has greatly altered the prognosis of this disease. Whereas in former times the diagnosis of teratoma testis with metastases meant a uniformly lethal termination, it is becoming increasingly evident that with adequate irradiation certain types of highly malignant testicular neoplasms may be completely controlled even though demonstrable retroperitoneal metastases were present. It has been known for some time that various testicular tumors and their metastases react quite differently to irradiation. In certain instances the primary tumors and their metastases disappear precipitately and do not recur within a period of years. In other cases the primary tumors react with varying promptness, usually do not recur, whereas the metastases react well, may completely disappear so far as palpation can detect, but recur after a varying interval. Still another group is quite radioresistant. Incidental observations from time to time have convinced us that a considerable degree of correlation exists between the pathologic histology, clinical course and radiosensitivity in this group of tumors and the present paper summarizes the results of a study of the available material in the endeavor to confirm or disprove the supposed correlation.

Up to approximately the end of 1928, 150 cases of testicular neoplasms had been observed in this hospital. In by far the majority of instances the primary tumor had been removed in some other institution where a diagnosis was made and from whence the patient was referred to the Memorial for irradiation treatment. In certain instances the primary tumor was never removed, the diagnosis resting on the conformation of the tumor, the presence of palpable metastases, and the reaction of one or both to irradiation. In forty-two of the 150 cases the testis was removed either before or after irradiation at this or at another hospital and the pathological examination made. The present report deals only with these forty-two cases verified in our own laboratory.

Some fifteen years ago the first patients with testicular tumors were irradiated at this hospital. It was a fortunate circumstance that the first few cases had tumors of the very radiosensitive, embryonal, anaplastic, carcinoma type, and the spectacular disappearance of the metastatic masses was sufficiently dramatic to force one to realize the importance of this revolu-

tionary change in the treatment of testicular teratoma. From that time on these tumors have been consistently handled by irradiation. Certain general principles rapidly became obvious. Surgery assumed an importance considerably below that of irradiation and its apparent value has so dwindled that it is a matter of discussion at the present time whether any surgical procedure at all should be carried out in these cases. We will consider this point later. Some tumors rapidly disappeared under irradiation, others were but slightly affected. Some metastases vanished only to reappear, indicating the necessity of increasing the irradiation in this group. In earlier years no method other than trial and error could be utilized. In time it became apparent that the reaction of the tumor mass to irradiation indicated to some degree the type of tumor. The anaplastic embryonal carcinomas diminished rapidly and often wholly disappeared, whereas tumors containing more differentiated structures tending toward the adult type frequently failed to react. The fact became gradually apparent that the highly malignant anaplastic carcinoma was actually less to be feared than its less malignant-appearing associates. When it became desirable to correlate tumor structure with clinical behavior, on the basis of experience both in this and in other tumor fields as to the histological diagnosis of probable radiosensitivity, the following working table was constructed. To test the validity of the suppositions made in the table we have examined the records of the forty-two cases above noted. As might be expected, not all the older charts contain conclusive statements as to the rate of regression under irradiation. There are enough cases in the two main tumor groups, anaplastic embryonal carcinoma, embryonal adenocarcinoma, to check the tabulation. The other groups have occurred too rarely to be of value in drawing conclusions.

In constructing this working table all of the slides on the various cases were reviewed. Unfortunately in the majority of instances the gross material is no longer available. Furthermore the destructive effects of radiation often reduce the testicular tumor to a necrotic, caseous mass, in which it may be very difficult to secure a region which gives much indication of the histology of the original tumor. Indeed in this hospital previously to the accumulation of sufficient experience in the microscopic appearance of radiated testicular tumors, the diagnosis of gunma has been made pathologically in cases behaving clinically like the very radiosensitive teratomas. The table is not intended as a classification of testicular tumors. It is a summary of the malignant types of proliferation found in the slides available from the forty-two cases studied. Of the forty-two cases at least thirty-eight would appear to belong in the embryonal group. Of the remainder, the three cases classified as carcinoma, adult type, tubule origin, considerable doubt must exist in the absence of complete study of the gross material especially as regards the location of the tumor in the testis. In no one of these three cases is the data sufficient to exclude a teratoid origin. Moreover in another case not included in the present material—a case which histologically very strongly suggested an origin of the tumor from tubule cells—the patient was a child of eight years,

an age certainly unusual for the development of cancer. Quite recently Desjardins, Squire and Morton<sup>1</sup> have once more concluded that the common embryonal carcinoma with lymphoid stroma is derived from adult spermatogonial cells, thus sharing the opinion of Chevassu<sup>2</sup> and others, of late Dew.<sup>3</sup> They base their conclusions on the common property of radiosensitivity of these tumors and of spermatogonial cells in the normal organ, at best a doubtful criterion especially since the authors make no effort to dispose of the evidence advanced by Wilms<sup>4</sup> and Ewing<sup>5</sup> for the teratoid origin of these types. In this connection it is of interest to note that the age distribution of "mixed, or teratoid tumors" and of "embryonal carcinoma" is quite similar

TABLE I

Reaction to Irradiation	Tumor type	Number of Cases
Radiosensitive	Embryonal carcinoma (diffuse tumors with very slight or no alveolar tendencies; embryonal carcinoma with lymphoid stroma)	24
	Lymphosarcoma	1
Moderately Radiosensitive	Embryonal adenocarcinoma and embryonal adenoma malignum (tumors with distinct gland-like cavities lined by cylindrical cells or with such gland-like cavities intermingled with areas of diffuse overgrowth)	10
	Embryonal myosarcoma (spindle-cell sarcomatous development in embryonal stroma, suggestive of muscle origin)	3
Radioresistant	Carcinoma, adult type, tubule origin (three cases of doubtful interpretation)	3
	Squamous carcinoma (developing in epidermal teratomatous structures)	1

(Chart I of the Desjardins, Squire and Morton). Quite recently Leroux and Hufnagel<sup>6</sup> have described another "seminoma" in which they demonstrated cartilage which latter they, influenced by Chevassu's interpretation of the seminoma, regard as a reactive metaplasia.

We may perhaps best deal with the material comprising this study under the following subdivisions: 1, the reaction of the primary tumor to radiation; 2, the behavior of the metastases; 3, the known length of time during which the primary tumor existed previous to the beginning of treatment; 4, the prognosis so far ascertained for different histologic types; 5, an analysis of certain failures.

When we attempt to analyze the available data on the reaction to irradiation in the anaplastic group of tumors we immediately meet with difficulties since of twenty-four histologically verified tumors of this variety, nineteen had been removed at some other institution previous to any irradiation treatment. The remaining five tumors diminished very rapidly in size follow-



ing irradiation and within a period of two to three weeks were reduced to one-third or less of their previous dimensions. In embryonal adenocarcinoma or embryonal adenoma malignum, tumors consisting of a teratoid glandular malignant proliferation with more or less well-defined glandular structures, of twelve verified cases, six entered the clinic after orchidectomy had been performed at another hospital. Of the remaining cases, three failed appreciably to diminish in size after treatment, one decreased but little, another decreased slightly, then after a stationary period of eight months, it increased in size; the sixth showed marked diminution, being reduced (in one week) to half its former dimensions. The lymphosarcoma reacted promptly and markedly to irradiation but subsequently terminated fatally in the usual manner of these tumors. The tumors classified as myosarcoma, squamous carcinoma in adult teratoma, and adult carcinoma were but slightly influenced by irradiation treatment. We may therefore conclude that the embryonal anaplastic carcinomas react like highly radiosensitive tumors, the embryonal adenocarcinomas with well-formed glandular structures are considerably less sensitive, and the other tumors in our collection are quite radioresistant. One might therefore be inclined to conclude that from the reaction of the primary testicular tumor some definite indication as to its type might be determined. This is true to a certain extent. Nevertheless certain other factors must necessarily enter into the matter, for in an adult cystic teratoma with embryonal elements capable of metastasizing, the irradiation may completely destroy the more active cellular portions and yet leave the adult structures relatively unaltered. One would therefore be misled into believing that the treatment was without effect, whereas as a matter of fact it had accomplished its purpose. In one other cellular tumor with many features justifying the diagnosis of choriocarcinoma testis the irradiation almost entirely destroyed the local tumor yet the testicular mass remained for several weeks unaltered. This lack of diminution in size was the result of thrombosis and infarction of the tumor vessels, practically converting the tumor mass into a hematoma, which of course did not diminish under irradiation.

The behavior of metastases toward irradiation is a complicated matter which, with our present material, is not clearly analyzable. Without autopsy or biopsy tissue from the retroperitoneal masses it is not possible to ascertain the exact structure of the metastases. Of course biopsy is wholly contraindicated. In complex teratomas one does not know which element or elements have metastasized. In embryonal adenocarcinomata one does not know whether the well-defined glandular form persists in the metastases or whether the latter are more anaplastic and hence more radiosensitive. Of the group of embryonal anaplastic carcinomas we have data in fifteen cases on the behavior of metastases. In one case only did the metastatic tumor fail to regress appreciably under treatment. In the remaining cases the metastatic masses showed marked or complete regression in from three weeks to ten months. Thus some disappeared in a spectacular fashion while others diminished much more slowly. In the more differentiated glandular teratoid adenocarcinomas

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or malignant adenomas data is available in six instances. Four tumors reacted markedly to irradiation suggesting that they were perhaps more cellular and anaplastic than the primary tumors. In the two remaining cases the tumor metastases failed to regress.

Of twenty-four patients with embryonal anaplastic carcinomata, ten are clinically well. Of these cases four had metastases. In reporting these cases we are concerned only with the histologically verified cases, thereby leaving out many clinically undoubted tumors successfully treated but without pathological material for personal study. The metastases in the four cases above mentioned were in the following locations: right abdomen, right inguinal region and right abdomen, left hypochondrium, left upper abdomen. These cases are well—that is, free from demonstrable disease, two years and seven months, three years and eight months, three years and nine months, and ten years. Two verified cases of embryonal adenocarcinoma are clinically free from disease. Of these cases one had metastases in the right upper abdomen. This patient is clinically well four years and ten months.

The following case is of interest in demonstrating the enormous quantity of irradiation required to destroy these tumors and the uselessness of small dosages of X-ray or radium.

The patient was a negro chauffeur, aged thirty-seven years. He was admitted to the hospital in May, 1925, with a history of painless swelling of the right testis over a period of five months. The testis steadily increased in size and two weeks before admission first became painful. Three months prior to entering the hospital the patient began to cough and had frequent night sweats. He had lost thirty-six pounds in weight. Examination revealed a tumor of the right testis measuring fourteen centimetres in circumference. A mass 5 x 7 centimetres was palpated in the right abdomen and X-rays of the chest showed extensive pulmonary metastases. In addition there was a hard supraclavicular node measuring 1 x 2 centimetres. No operation was done. The patient was treated with a great deal of high voltage X-ray and with radium. The testis was reduced to a firm fibrotic mass. The metastases disappeared and the patient is now clinically well and free from demonstrable disease for four and a half years from the time treatment was first instituted. The skin shows practically no effect from the treatment. The radiation employed in this case is charted in the following table.

TABLE II  
*Radium treatment*

Date	Milli-curies	Time	Milli-curie hours	Filter	Distance	Location of treatment		Apparatus
10/ 6/26	1935	6 hrs. 10 min.	12000	2 mm. brass	10 cm.	Ant.	epig.	emanation pack
10/ 7/26	1844	4 hrs. 12 min.	8000	2 mm. brass	10 cm.	Ant.	epig.	emanation pack
8/25/27	4000	3 hrs.	12000	2 mm. br. 0.5 mm. pt.	15 cm.	L.U.Q.	post.	element pack
8/31/27	4000	3 hrs.	12000	2 mm. br. 0.5 mm. pt.	15 cm.	L.U.Q.	post.	element pack
9/ 5/27	4000	3 hrs.	12000	2 mm. br. 0.5 mm. pt.	15 cm.	L.U.Q.	ant.	element pack
9/10/27	4000	3 hrs. 15 min.	13000	2 mm. br. 0.5 mm. pt.	15 cm.	L.U.Q.	ant.	element pack
9/17/27	4000	2 hrs. 45 min.	11000	2 mm. br. 0.5 mm. pt.	15 cm.	L.U.Q.	post.	element pack
9/20/27	4000	3 hrs.	12000	2 mm. br. 0.5 mm. pt.	15 cm.	L.U.Q.	post.	element pack

*X-Ray treatment*

Date	Time	Milli-amps.	Filter	Sp. Gap	Focal dist.	Region treated
5/ 7/25	60 min.	4	0.5 mm. cu. 1.0 mm. al.	90	50 cm.	Epigastrium
5/ 8/25	60 min.	4	0.5 mm. cu. 1.0 mm. al.	90	50 cm.	Right lower abdomen
5/ 9/25	25 min.	4	0.5 mm. cu. 1.0 mm. al.	90	50 cm.	Right testis and cord
5/13/25	60 min.	4	0.5 mm. cu. 1.0 mm. al.	90	50 cm.	Right chest posterior
5/15/25	60 min.	4	0.5 mm. cu. 1.0 mm. al.	90	50 cm.	Left chest posterior
5/18/25	60 min.	4	0.5 mm. cu. 1.0 mm. al.	90	50 cm.	Right chest anterior
5/19/25	60 min.	4	0.5 mm. cu. 1.0 mm. al.	90	50 cm.	Left chest anterior
1/12/26	60 min.	4	0.5 mm. cu. 1.0 mm. al.	90	50 cm.	Right groin and testis
1/15/26	60 min.	4	0.5 mm. cu. 1.0 mm. al.	90	50 cm.	Right abdomen anterior
1/19/26	60 min.	4	0.5 mm. cu. 1.0 mm. al.	90	50 cm.	Right abdomen post.
1/20/26	60 min.	4	0.5 mm. cu. 1.0 mm. al.	90	50 cm.	Right chest posterior
1/25/26	60 min.	4	0.5 mm. cu. 1.0 mm. al.	90	50 cm.	Right chest anterior
1/27/26	60 min.	4	0.5 mm. cu. 1.0 mm. al.	90	50 cm.	Left chest anterior
1/29/26	60 min.	4	0.5 mm. cu. 1.0 mm. al.	90	50 cm.	Left chest posterior
4/ 2/26	25 min.	4	0.5 mm. cu. 1.0 mm. al.	90	50 cm.	L. Supraclavicular
5/24/26	60 min.	4	0.5 mm. cu. 1.0 mm. al.	90	50 cm.	Epigastrium, right
5/27/26	60 min.	4	0.5 mm. cu. 1.0 mm. al.	90	50 cm.	Abdomen anterior
6/ 1/26	60 min.	4	0.5 mm. cu. 1.0 mm. al.	90	50 cm.	Epigastrium, right
6/ 1/26	60 min.	4	0.5 mm. cu. 1.0 mm. al.	90	50 cm.	Abdomen, posterior
6/ 4/26	7 min.	20	0.5 mm. cu. 1.0 mm. al.	90	50 cm.	Right groin & scrotum
	(water cooled tube)					
8/26/26	40 min.	4	0.5 mm. cu. 1.0 mm. al.	90	50 cm.	Mediastinum, centre, ant.
8/28/26	14 min.	20	0.5 mm. cu. 1.0 mm. al.	90	50 cm.	L. upper abdomen ant.
	(water cooled tube)					
8/30/26	(water cooled tube)	20	0.5 mm. cu. 1.0 mm. al.	90	50 cm.	L. upper abdomen post.
10/ 6/26	10 min.	20	0.5 mm. cu. 1.0 mm. al.	90	50 cm.	Epigastrium posterior
10/ 8/26	7 min.	20	0.5 mm. cu. 1.0 mm. al.	90	50 cm.	Epigastrium posterior
10/23/26	40 min.	4	0.5 mm. cu. 1.0 mm. al.	90	50 cm.	Epigastrium anterior
11/30/26	40 min.	4	0.5 mm. cu. 1.0 mm. al.	90	50 cm.	Epigastrium anterior
12/30/26	40 min.	4	0.5 mm. cu. 1.0 mm. al.	90	50 cm.	L. abdomen oblique
1/ 4/27	40 min.	4	0.5 mm. cu. 1.0 mm. al.	90	50 cm.	R. abdomen oblique
1/15/27	40 min.	4	0.5 mm. cu. 1.0 mm. al.	90	50 cm.	L. abdomen oblique
1/26/27	5 min.	30	0.5 mm. cu. 1.0 mm. al.	90	50 cm.	R. abdomen oblique
	(the last and all subsequent treatments with water cooled tube)					
2/ 4/27	5 min.	30	0.5 mm. cu. 1.0 mm. al.	90	50 cm.	R. abdomen, upper post.
2/11/27	5 min.	30	0.5 mm. cu. 1.0 mm. al.	90	50 cm.	R. abdomen, upper ant.
2/18/27	5 min.	30	0.5 mm. cu. 1.0 mm. al.	90	50 cm.	R. abdomen, upper post.
3/22/27	6 min.	30	0.5 mm. cu. 1.0 mm. al.	90	50 cm.	R. abdomen, upper ant.
3/22/27	10 min.	30	0.5 mm. cu. 1.0 mm. al.	90	50 cm.	R. scrotum and groin
3/26/27	6 min.	30	0.5 mm. cu. 1.0 mm. al.	90	50 cm.	R. abdomen, upper ant.
3/29/27	6 min.	30	0.5 mm. cu. 1.0 mm. al.	90	50 cm.	R. abdomen, upper post.
4/12/27	6 min.	30	0.5 mm. cu. 1.0 mm. al.	90	50 cm.	L. abdomen, upper post.
4/19/27	3 min.	30	0.5 mm. cu. 1.0 mm. al.	90	25 cm.	L. abdomen, upper ant.
4/26/27	6 min.	30	0.5 mm. cu. 1.0 mm. al.	90	50 cm.	Posterior mediastinum
5/ 3/27	10 min.	30	0.5 mm. cu. 1.0 mm. al.	90	50 cm.	R. groin and scrotum

Where irradiation has failed to control the tumors analysis has shown that the treatment has been insufficient. Indeed, during the past two years the quantity of irradiation received by these patients has been very nearly doubled. There are, of course, cases in whom the disease is so far advanced where metastases are enormous and patients are cachectic, and under such conditions sufficient treatment to control the tumors cannot be administered. These die before they can be sufficiently irradiated. One case autopsied within

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the last few months may illustrate this situation. The patient, aged thirty-eight years, applied for treatment three and one-half years after removal of the primary tumor. A very large right abdominal metastasis melted away under treatment and the patient gained strength. However, he soon became worse and died only four months after admission. At autopsy the metastatic masses completely filled the abdominal cavity, infiltrated the diaphragm, extended up along the aortic and mediastinal nodes to the supraclavicular region. On the irradiated side the tumor was reduced to a spongy, hæmorrhagic, fibrinous reticulum with practically no tumor cells in evidence in sections, whereas on the side which had had no irradiation the tumor was very active. The size and distribution of the metastases in this case had not been suspected and the patient was inadequately irradiated. This tumor was of the highly radiosensitive type. The more radioresistant embryonal adenocarcinomas with distinct glandular formations will undoubtedly continue to from time to time defy successful irradiation treatment. In such cases the struggle becomes a contest between the amount of irradiation necessary to control the tumor and the quantity which can be withstood by the patient.

Cases		Cases	
9-12 months . . . . .	1	4-5 years . . . . .	3
1-1.5 years . . . . .	5	5-6 years . . . . .	3
1.5-2 years . . . . .	9	6-7 years . . . . .	2
2-2.5 years . . . . .	6	7-8 years . . . . .	0
2.5-3 years . . . . .	2	8-9 years . . . . .	2
3-4 years . . . . .	6	9-10 years . . . . .	1
10 years . . . . .	1		

Much discussion has arisen relative to the propriety of removing the primary tumor after its irradiation. At this hospital it is the custom to perform an orchidectomy for the following reasons: (1) To determine the type of tumor and to thereby gain some information as to the probable prognosis and the probable amount of irradiation necessary. (2) To obviate the necessity of subsequent over-irradiation of the opposite testis. (3) To prevent a local recurrence in a possible adult teratoma where the presumption is that resumption of activity of more anaplastic portions may again occur. These last two reasons for orchidectomy are at present merely theoretical.

Strangely enough it appears quite impossible to ascertain from the history of the duration of the primary tumor any definite information as to its type. If the histories given by patients are correct then it would seem that tumors classified histologically and behaving clinically like embryonal anaplastic carcinomas may have been present for from three months to seven years. This is perhaps a valid argument for interpreting these tumors as a one-sided development of a complex teratoid tumor whose cellular portions have obliterated adult differentiated portions existing over a long period. On the other hand the history of development of the embryonal adenocarcinomas or embry-

onal malignant adenomas ranges from three months to one and one-half years. In other words the most radiosensitive tumors are not necessarily the most rapidly growing.

At the time this article is written we are able to present data on 113 patients treated and followed in this hospital. Of these 113 cases, forty-one are living and clinically free from disease. The above table indicates the time duration:

Of these 113 patients, thirteen were primary operable cases with no palpable metastases. Ten, or seventy-nine per cent., are alive and clinically free from disease. Sixteen were primary inoperable cases with demonstrable metastases. Four, or twenty-five per cent., are clinically well. Three were recurrent operable cases (local recurrences). Three, or 100 per cent., are clinically well. Eighty-one were recurrent cases with inoperable local recurrences and inoperable metastases. Twenty-four, or thirty per cent., are without evidence of disease.

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## KAOLIN IN THE TREATMENT OF EXTERNAL GASTRO- INTESTINAL FISTULAS

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THE types of fistulas considered in this report are the spontaneous gastric and duodenal fistulas and such artificial fistulas as ileostomy, cecostomy and sigmoidostomy.

It is generally known that the continual discharge from fistulas of the gastro-intestinal tract causes pathologic changes of the surrounding skin, varying from a mere redness for a short distance around the wound to an extensive raw-looking area. The degree of excoriation and digestion seems to bear a definite relation to the enzymatic activity of the fistulous portion of the gut, the intensity being greatest in fistulas of the upper digestive tract, less in those of the right half of the colon and least in those of the left half of the colon. In some cases of duodenal fistulas the entire abdominal wall may be involved, presenting a beefy surface with the recti muscles standing out raw and bare.

Of the artificial fistulas, ileostomy presents the most difficulties in management because of the inevitable digestion occurring around the stoma. In those cases in which the ileum is drawn out into the main incision and opened immediately, the digestion around the wound may be so marked as to lead to evisceration under the least strain. In cecostomies, digestion may be quite as severe as in ileostomy, and in sigmoidostomies, there is little or no excoriation unless diarrhoea occurs. But aside from the discomfort these lesions cause, they prolong the patient's stay in the hospital by postponing the closure of the artificial anus where a closure is intended.

The use of such preparations as vaseline, zinc oxide ointment and other oleaginous substances as a protective for the skin, although recommended by many authors, is not only futile but actually harmful. They make the wound "messy" and retain the discharge and thus promote further digestion. The discharge seems to have a malignant propensity to lift up the vaseline layer and to burrow under it to get to the underlying skin. The same objection applies to paraffine, parresine and collodion.

It is not generally known that kaolin, in addition to being an internal medicament for various gastro-intestinal disorders, is also of benefit when used as a dressing in these cases. The power of kaolin to inhibit enzymatic activity was demonstrated by Petersen<sup>1</sup> in 1917. He found that on mixing .2 gm. of kaolin with 7.5 c.c. of duodenal and upper jejunal contents the rate of proteolysis was reduced by about 20 per cent. This figure is not impressive at first sight, but when the relatively small quantity of kaolin is considered, its marked anti-enzymatic activity is at once apparent. Smith and Christensen,<sup>2</sup> in testing out different substances that would tend to inhibit enzymatic activity in the discharge from intestinal fistulas, found that kaolin and charcoal

were the most useful. Because of the objectionable color of charcoal, they preferred kaolin. They used sterile kaolin in the form of a paste made with glycerine. After applying the paste, they surrounded it with kaolin powder.

In the hope that the absorptive power of kaolin, as demonstrated by Petersen, might be beneficial in artificial ani around which there was digestion, we started using it in 1926. The results encouraged us to extend its use to high fistulas. Our experience covers thirty-one cases, which may be tabulated as follows:

Four, duodenal fistulas; five, ileostomy—through stab wounds; three, ileostomy in main wound (infants with atresia of colon); four, cecostomy; fifteen, sigmoidostomy. We prefer the powder form as being simpler, more soothing and more absorbent for moisture. It is not necessary to sterilize it. Hektoen and Rappaport<sup>3</sup> and Rappaport<sup>4</sup> showed that when properly applied in a dry powder, kaolin removed not only diphtheria bacilli but practically all bacteria of the nose in the course of three or four days. It must be cautioned that crude kaolin is moist and lumpy and has less adsorptive power than the thoroughly dried and powdered product. At present, however, the commercial houses put out a very high grade of product so that one does not have to resort to drying and powdering and sieving it, as Rappaport had to do. Kaolin should not be used in the small amounts in which the ordinary dusting powder is used, but literally be heaped around the opening and over it. The caking that occurs does not offer any impediment to the free flow of the discharge. Immediately upon application the smarting and burning stop. The angry appearance of the part is soon lost and healing takes place rapidly.

In the treatment of the high fistulas, oil tampons<sup>5</sup> and irrigation with sterile water have been tried with unconvincing results. The use of atropine and sodium fluoride to inhibit the secretions is of little value.<sup>6</sup> Johansen<sup>7</sup> injected 1 per cent. citric acid into the fistula and reported favorable results in two cases, and recently Potter<sup>9</sup> has advocated the treatment of the various external intestinal fistulas with beef juice and dilute hydrochloric acid. The removal of the discharge by aspiration was advocated by Jones and Williams.<sup>8</sup> Erdman,<sup>10</sup> in 1921, devised a continuous suction pump which proved successful in the healing of a traumatic duodenal fistula. Cameron<sup>11</sup> reported a favorable result with the use of his electric pump, and Lahey<sup>12</sup> two cases in which the use of his continuous water suction pump resulted in prompt healing. In our four cases of high fistulas we have obtained excellent results by the use of this method of continuous suction with a liberal application of kaolin powder around the wound. The kaolin powder prevented digestion from an overflow of the discharge and hastened the healing of the digested areas.

In our five cases of ileostomy in which the ileum was drawn out through a stab wound, little or no irritation was encountered. In the three cases of infants, on whom, because of the critical condition of the patients, the ileum was brought out into the lower corner of the main wound and opened immediately, two had a slight infection and one had a severe infection, but digestion was controlled and evisceration was prevented. When one considers that

## KAOLIN EXTERNAL GASTRO-INTESTINAL FISTULAS

a large majority of these patients die as a result of evisceration the prevention of this almost always fatal complication in three consecutive cases was extremely gratifying.

The same good result was duplicated in our four cases of cecostomy and fifteen cases of sigmoidostomy. The powder was applied as soon as the externalized knuckle of bowel was opened. A slight reddening of the skin was found in one case of cecostomy. This was due to the use of kaolin in insufficient amounts and was soon remedied when liberal quantities were applied. In the fifteen cases of sigmoidostomy no irritation occurred. In one case in which the artificial anus was made immediately in the operative wound, and in which an infection was thought inevitable, we had the pleasure of seeing the wound heal by primary union. In all these cases of artificial anus kaolin undoubtedly shortened the patients' hospital stay at least two weeks.

### SUMMARY

1. Kaolin is recommended as a dressing in cases of external gastro-intestinal fistula.
2. It need not be made into a paste. The powder is simpler, more soothing and more absorbent and adsorptive. It is not necessary to sterilize it.
3. It should not be used in the quantities of an ordinary dusting powder, but liberally applied.
4. It prevents irritation and digestion of the wound by the discharge, relieves burning and smarting and insures prompt and uninterrupted healing.
5. The use of vaseline and other oleaginous substances is harmful.

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# TRANSACTIONS

OF THE

## NEW YORK SURGICAL SOCIETY

STATED MEETING HELD NOVEMBER 13, 1929

THE PRESIDENT, DR. EDWIN BEER, IN THE CHAIR

### RESECTION OF COSTAL ARCH FOR TUBERCULOSIS

DR. CARL EGGERS presented a man, 69 years old, who was admitted to the Lenox Hill Hospital February 28, 1927, on account of a discharging sinus over the right lower chest. About five months before that time, in September, 1926, he had noticed a small lump over one of the lower ribs on the right side. It had gradually increased in size and had been tender to touch. Two months after onset there had been a spontaneous perforation with discharge of pus. In spite of medical treatment drainage had continued. There was no other complaint. No cough. No constitutional symptoms except weakness.

The patient was quite anæmic, but looked well preserved for his age. He had several carious teeth, but no other focus of infection. He had a mitral regurgitation and a bilateral direct inguinal hernia. Examination of the lungs was negative.

Over the region of the right costal arch there was a swelling with a sinus tract which gave the appearance of being a chronic lesion. The swelling was flattened and about two inches in diameter. At the apex of this swelling, and close to the junction of the cartilages with the sternum, there was a sinus tract in an ulcerated area about one inch in diameter and having overhanging edges. It discharged sero purulent material. The ulcerated area was adherent to the underlying tissues. A probe could be inserted one and a half inches and seemed to pass inward between the cartilages of the seventh and eighth ribs to a deeper focus. No connection with an intrathoracic focus could be made out. A diagnosis of suppurative chondritis was made. During the next few days the temperature reached 101 every evening. There was no cough or sputum. Wassermann examination was negative. Röntgen-ray examination of the chest showed the bronchial tree somewhat intensified, but there was no evidence of pulmonary tuberculosis. The involved costal cartilages could not be demonstrated.

March 3, 1927, under local one-half per cent. novocain anæsthesia, an incision was made along the margin of the right costal arch and surrounding the sinus tract. The skin muscle flap was retracted, exposing all the cartilages. The suppurative process involved several of the cartilages and had partly destroyed them. The remaining portions were yellow and brittle. A radical operation was done, removing the entire affected costal arch and a small portion of three ribs, apparently the eighth, ninth and tenth, as well as a narrow margin of sternal border. Split tube drains were inserted and the flap was partly sutured back into place.

Culture of the deeper portions of the wound showed hæmolytic streptococci, while the pathological examination showed granuloma, probably tuberculous. Suppuration continued in the wound and the patient was discharged five weeks after operation, unhealed. On account of a persistent

## EXERESIS OF PHRENIC NERVE FOR PULMONARY TUBERCULOSIS

sinus he had to be readmitted June 1, 1927. The wound was reopened at the sternal end as well as at the costal end. Necrotic cartilage was found representing apparently the cartilages of the sixth and seventh ribs. They were completely removed together with a small portion of each rib and of the sternal border. The eleventh rib with its cartilage was visible and palpable, but apparently not involved. The wound was thoroughly curetted and packed with iodoform gauze. Convalescence was uneventful. The wounds healed promptly and the patient was discharged cured two weeks after admission. He has had no further trouble.

## EXERESIS OF PHRENIC NERVE FOR PULMONARY TUBERCULOSIS

DOCTOR EGGERS presented a young man, sixteen years old, who was referred to the surgical service of the Lenox Hill Hospital, October 16, 1929, for exeresis of the phrenic nerve and possibly an extropleural thoracoplasty. He had a well advanced pulmonary tuberculosis of four years' duration, affecting the entire left lung. The disease started with a pleural effusion, and later gave rise to cough with expectoration containing tubercle bacilli. He was treated at the New Jersey State Sanatorium for Tuberculosis for eighteen months and improved a great deal during this time. Ten months ago he developed influenza with a temperature of 102. Since that time he has gradually lost weight and strength, and cough and expectoration have increased. About six weeks ago he had hemoptysis for an entire day, followed by rusty sputum for a week. For two weeks prior to admission attempts had been made to induce a pneumothorax, but they had not been successful.

On admission the boy was anæmic looking and weighed 93 pounds. He ran a slight temperature up to 100.2 with a pulse of 90. He coughed very little, but the sputum was positive for tuberculosis. Examination of the chest showed extensive involvement of the left lung with retraction and diminished expansion of that side and displacement of the heart to the left.

Röntgen examination verified this finding. The right lung was reported clear, while the left showed chronic pulmonary tuberculosis with cavitation. In addition to the pulmonary involvement the patient has a cardiac lesion. At first it seemed to be of an organic nature, but careful study by means of the electro-cardiograph has established it to be a neurosis. There are, no doubt, extensive adhesions between the pericardium and the pleura, but apparently no intrapericardial adhesions.

With the failure of pneumothorax treatment on account of intrapleural adhesions surgery was definitely indicated in this boy. The Röntgen picture shows that nature has done all it can do to bring about contraction and fibrosis of the affected lung. The chest wall is retracted and less mobile than normally and the mediastinum has been displaced towards the affected side. In spite of that the process is advancing and hemoptysis recently took place. An exeresis of the phrenic nerve was decided upon, to be followed by renewed attempts at induction of a pneumothorax. More radical operation carried a considerable risk in this case on account of the condition of the heart.

The operation was performed October 19, 1929, under local one-half per cent. novocain infiltration. A three-inch incision was made above the left clavicle and parallel to it. The phrenic nerve was exposed without difficulty. Pinching it elicited pain in the left shoulder. The nerve was injected with novocain, grasped with a forceps and divided. It was then gradually twisted around the forceps and drawn out of the thorax. This caused considerable pain in the diaphragm on that side. About five inches of the nerve were removed. The wound healed *per primam*.

A Röntgen examination a few days later showed the diaphragm to have risen the distance of one rib and one intercostal space and to be motionless. The patient is shown to demonstrate the actual gain in diminution of the thoracic cavity obtained by exeresis of the phrenic nerve.

Should attempts at induction of a pneumothorax be unsuccessful, it is expected to perform an extrapleural thoracoplasty in several stages.

#### EXTRAPLEURAL THORACOPLASTY FOR PULMONARY TUBERCULOSIS

DOCTOR EGGERS presented a woman, thirty-six years old, who was admitted to the surgical service of the Lenox Hill Hospital, May 20, 1926, for the purpose of having an extrapleural thoracoplasty performed. She had been under treatment at different clinics in New York for the past fifteen years, but had never been confined to a sanitarium. She had done her own housework and taken whatever hygienic measures she could. Every summer she had managed to spend considerable time in the country. During the last year she had been getting worse; she complained of vomiting a great deal which made her afraid to take food. She had night sweats and had run a moderate afternoon temperature. Her cough had become almost continuous and productive of large amounts of greenish expectoration. During the last two weeks the sputum had been blood tinged. She was bedridden and steadily losing ground. She had lost eleven pounds in the last three months. Her best weight had been one hundred and fifteen pounds a year before. Pneumothorax treatment had not been successful. There was nothing else in the past history of any importance, nor were there symptoms of disease referable to other organs. She was married and had three healthy children who had never shown signs or symptoms of pulmonary disease. One brother and one sister had died of pulmonary tuberculosis thirteen and twenty years before, respectively.

Examination showed a frail, almost emaciated, middle-aged woman, who coughed continuously. There was evidence of extensive pulmonary involvement on the left side with some retraction of the thoracic wall and diminished expansion. There was also dullness associated with rales and bronchovesicular breathing over the right apex. The heart action was good, the temperature 100.2, and the pulse ranged from 90 to 110. Her weight was 95 pounds.

While under observation during the following week the highest temperature was 101, highest pulse rate 116, and respiration was 28. Repeated sputum examinations showed tubercle bacilli. The blood count showed seventy-eight per cent. hæmoglobin, 3,900,000 red blood cells, 7,600 white blood cells, fifty-six per cent. polymorphs, two per cent. large lymph., forty-two per cent. small lymph. Röntgen examination of the chest showed the heart to be moderate in size and definitely drawn over towards the left. Practically the whole left chest showed an active tuberculous involvement with evidence of at least two large cavities. There was also evidence of involvement of the right apex.

With the coöperation of the Tuberculosis Department an operation was decided on, to be divided into three stages; the first, exeresis of the phrenic nerve; second, resection of the lower ribs; third, resection of the upper ribs.

The first operation was done May 27, 1926. Under local one-half per cent. novocain anæsthesia a two-inch incision was made above the left clavicle and parallel to it. The phrenic nerve was easily exposed. Pinching it caused pain in the anterior part of the left shoulder, just below the outer end of the clavicle. The nerve was therefore injected with novocain and divided. It was caught with a forceps and by a twisting motion was gradually

drawn out. This caused severe pain in the left upper abdomen, and while the nerve was being withdrawn, the patient repeatedly complained, "Oh my heart." There was, however, no change in her pulse and her color remained good. Withdrawal was continued until what looked like the entire nerve had been removed. It was ten or twelve inches long. The wound was closed with silk. It healed by primary union and an X-ray taken subsequently showed the diaphragm to have risen about one rib and one intercostal space. The patient developed fever up to 104, attributed to increased activity in the lungs, but this was not considered a contra-indication to further operation. As a matter of fact the tuberculosis department urged that we proceed with the treatment.

The second operation was performed June 9, 1926. Under local one-half per cent. novocain anæsthesia an incision was made along the course of the ninth rib and then upward posteriorly over the eighth, seventh, sixth and fifth ribs. The flap so outlined was retracted upward and forward carrying the scapula along. About four inches of the ninth, eighth, seventh, sixth and fifth ribs were resected subperiosteally. The parietal pleura was found to be very thin and a small perforation was accidentally made in the ninth and in the sixth interspaces. Both openings were immediately closed by means of a few plain catgut sutures and seemed to cause no difficulty. The wound was closed without drainage, using interrupted chromic catgut for the muscles and continuous plain catgut for the skin. The patient stood the operation well. She reacted nicely from it and the temperature gradually came down until the highest evening rise was 99.6. She began to feel better and stated that the cough was decidedly less. A small marginal necrosis developed along the incision and somewhat delayed the last stage of the operation which was performed June 26, 1926. On account of the greater difficulty in gaining access to the upper ribs this operation was done under gas oxygen anæsthesia. The original incision was extended upward almost to the clavicle. The muscles were divided and the ribs exposed. About three inches of the fourth and third ribs, two inches of the second, and one and a half inch of the first rib were removed.

The wound was closed without drainage and healed by primary union. There was only slight reaction, the highest temperature reaching 100.6. Within a few days it was practically normal, only occasionally going up to 100. The patient was encouraged to be out of bed early, to carry herself erect and to breathe quietly and deeply. She made an uneventful recovery, but lost weight during her stay in the hospital, from 95 down to 88 pounds. She was discharged July 13, 1926, seventeen days after her last operation, and fifty-four days after admission. She then carried herself well, her shoulders were of equal height, the function of her left arm was good, and except for loss of weight she was decidedly improved. A Röntgen examination at this time showed complete collapse of the left side of the chest with no lung tissue visible. Such a finding is considered the desired result.

Since that time the patient has remained under observation. She is far from well, but is able to do her own housework. The present symptoms are probably due to the involved right upper lobe.

This patient was pronounced hopeless by the tuberculosis department before operation. She had been bedridden of late and was steadily losing ground. The continuous cough was exhausting her strength and unless one could put the left lung with its cavities at rest by collapsing it, the prognosis was bad. Pneumothorax treatment had not been successful and operation was therefore decided on in spite of the involvement of the right upper lobe.

## THORACOPLASTY FOR CHRONIC TUBERCULOUS EMPYEMA

DOCTOR EGGERS presented a woman twenty-four years old, who was admitted to the Lenox Hill Hospital October 25, 1921, on account of a discharging sinus of the right side of the thorax. She gave the following history: She had been well until the birth of her child two years before. Three days after confinement she had a chill and fever and developed pneumonia which was followed by a pleuritic exudate. A rib resection was done and open drainage established. The fluid is said to have been watery in character and not like pus. She was treated at the hospital for three months and then transferred to a tuberculosis sanitarium where she remained nine months. During most of this time she ran a temperature up to 105 and 106. At first she had been treated with simple drainage, later by the Dakin Carrel Method. For the past year she had been treated at home, chiefly by her husband who irrigated the cavity every evening with boric acid solution and who stated that the capacity had diminished from seven to two ounces. He also stated that tubercle bacilli had been found in his wife's sputum on one occasion.

On admission the patient complained chiefly of dyspnoea and profuse discharge from her wound. There was no cough. She was a frail, anæmic, young woman, who looked chronically ill and who had flushed cheeks. She weighed 90 pounds. The temperature was 99.4, and the pulse 102. Examination of the chest showed the right side flattened and expansion diminished. There was a scar posteriorly in the region of the ninth rib and at this place a sinus led into the thorax and discharged pus. A probe could be inserted its full length, and on account of this open thorax the physical signs on that side were difficult to interpret. Over the left side the breath sounds were emphysematous in character, and at the apex there were signs suggestive of tuberculosis. The heart was rapid; there was no displacement or enlargement made out.

On the basis of the history and findings a diagnosis of chronic empyema was made, probably of tuberculous origin and associated with pulmonary tuberculosis.

The patient was put on a high caloric diet, rest in bed, and Dakin-Carrel treatment in order to clean up the infected cavity preparatory to whatever operation might be contemplated.

During this period of treatment she was carefully studied. Her temperature reached 99.4 or 99.6 in the evening, and the pulse did not go above 100. The Wassermann was negative. The urine showed a faint trace of albumin, but was otherwise negative. There was no cough or expectoration. Examination of the discharge from the sinus showed streptococci and tubercle bacilli. Her skin reaction was positive for tuberculosis. Röntgen-ray examination after injection of the empyema cavity showed it to extend from the sinus in the ninth rib to above the sixth rib. There was a focus in the left apex suspicious of tuberculosis.

The question arose how best to treat this condition. To continue irrigations in the face of unsuccessful treatment by that method for two years did not seem logical. Nature had already collapsed the lung as far as it was able to within the rigid thorax. By an operation one could expect to mobilize the chest wall and allow it to come into contact with the collapsed lung and at the same time to remove the affected lining membrane of the cavity.

The first operation was performed under chloroform oxygen anæsthesia, November 14, 1921, and consisted of resection of a portion of the tenth, ninth, eighth, seventh, sixth and fifth ribs. The intercostal vessels were

## TUBERCULOSIS OF LUNG. TENSE PYOTHORAX

ligated and the muscles removed. The entire outer wall of the cavity was then removed. It was a half inch thick. A large flat cavity was exposed having a projection downward and forward along the costophrenic sinus and one upward posteriorly. The former was completely shelled out, liberating lung and diaphragm at that point. It was not thought wise to proceed further at this time, the cavity was packed with iodoform tampons and the muscles and skin were partly sutured. The convalescence was uneventful. No cough developed, and practically no increase in pulse or temperature.

The wound and tampons were not disturbed until the second operation, twelve days later, November 26, 1921. Upon reopening the wound it was found to be clean and without odor, and there was no retention of pus. A decortication of the lung was attempted, but could only be done incompletely in parts on account of the firm connection with the underlying lung tissue. Efforts were principally directed towards removing the thick layer of scar tissue at the angle of reflection of the pleura. In the attempt to separate the lung from the diaphragm the latter was accidentally incised for a distance of two inches. This slit was at once sutured with chromic catgut and subsequently did not give rise to trouble. In order to reach the upper part of the cavity and to make it possible for the chest wall to collapse three inches of the fourth rib and one inch of the third rib were resected. The intercostal muscles were not removed, but simply forced down into the cavity after the thickened pleura had been removed. An iodoform gauze tampon was placed to the oozing surface at the pleural reflection, while plain gauze tampons were used for packing the cavity. Another plain gauze tampon was placed under the scapula external to the intercostal muscles to favor collapse. The muscles and skin were partly closed. A week after the operation the tampons were removed under gas anæsthesia and two drainage tubes inserted.

After this second operation the course was somewhat more stormy than after the first. There were at times periods of fever up to 102 or even 103, but on the whole there was steady improvement to be noticed. The discharge gradually diminished, but did not cease entirely and the patient was discharged with a small sinus February 26, 1922. She had no cough, and no fever, and had gained four pounds in weight.

The pathological examination of the thickened pleural tissue removed at both operations showed tuberculosis.

The sinus healed after several months and she continued to gain in weight and strength. Now, eight years after operation, she considers herself well. She became pregnant at the end of 1922, but had it interrupted on our advice. In 1924 she went through a normal pregnancy.

It is of interest to report that the child which was born just before the onset of the pulmonary condition developed tuberculosis of the spine when about two years old. He was treated on a frame for a while and later had a bone graft inserted into his spinal column with a satisfactory result. The child is reported cured by his attending orthopedic surgeon.

## TUBERCULOSIS OF LUNG. TENSE PYOTHORAX.

DR. HOWARD LILIENTHAL presented a man, aged about twenty-eight, who came to him February 11, 1925. There had been a rapidly progressive tuberculosis with a number of hæmorrhages, the disease being confined chiefly to the right lung. Doctor Edgar Mayer, of Saranac, had employed artificial pneumothorax one year before. Refills were carried out for some months when a spontaneous pneumothorax occurred with great dyspnœa, fever and pain. Clear pleural fluid gradually became purulent and foul. When first

seen his chest was about three-quarters full of fluid and the lung was apparently well compressed. The temperature ran to more than 104 in spite of repeated aspirations, but although there was cough, there was no purulent expectoration. Respirations were 38; pulse as high as 134; heart apparently toxic. A mild intestinal tuberculosis had been diagnosed at Saranac, and there was irregular, abdominal distention. The heart was displaced far to the left. There was great emaciation.

The first procedure was thoracotomy in local anæsthesia, with resection of the eighth rib including its periosteum. Three quarts of foul pus by actual measure were removed without spilling. There was immediate improvement under Carrel-Dakin treatment, but the affected lung showed no tendency to expand.

February 26, 1926, the upper nine ribs were resected by the paravertebral route. About three weeks later the capacity of the pleural sac was found to be 210 cubic centimetres and a revision of the thoracoplasty was performed. At

FIG. 1.—Thoracoplasty to obliterate tuberculous empyema. Lipiodol injection shows syphon-like pocket. Note tube extending above into empty pleural space. Case of man age 28 years.

this time further sections of some of the ribs were taken away, although forty one inches of bone had been the total at the first operation. Four inches of the tenth rib were also resected by an incision parallel with the bone.

He was discharged from the hospital about two months after his first operation, but with the warning that further surgical procedures would be necessary to close the wound. In about two months he came back and at this time digital examination through the wound, and also X-ray pictures revealed a complicated condition of pocketing upward, downward and forward. (Fig. 1.) The tissues were almost cartilagenous in texture, so that at the operation which was then performed, the division had to be made with Liston's bone forceps. The entire wound was now left open.

After nearly two years, although the cavity contained less than forty cubic centimetres, drainage was still imperfect and again he was subject to operation; this time the entire pleural area was exposed to the eye.

Although this was followed by improvement with contraction of the main cavity, two more revisions were required to expose and drain residual pockets

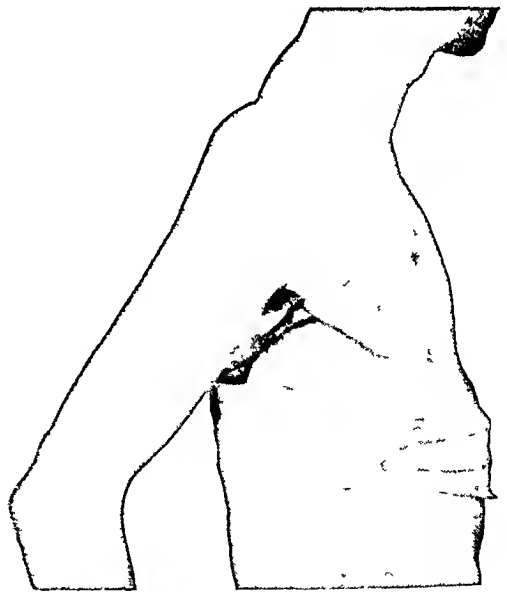


FIG. 2.—The wound is completely healed and the elastic adhesive plaster is worn for temporary support only. It has since been discarded. Beginning alopecia areata. Case of man age 28 years.

## TUBERCULOSIS OF THE LUNGS. PARAVERTEBRAL THORACOPLASTY

which had formed. But at last all raw surfaces were covered by epithelium and in December, 1928, the wound was definitely healed. No small credit is due to the employment of iodoform and ether for the purpose of disinfecting the pockets which seemed continually to reform. From the beginning of the employment of this remedy there was steady improvement in the quantity and character of the discharge and in the formation of epithelium covering. The reporter said that he had since made use of this solution in similar cases with much gratification. Ether and iodoform is more penetrating than the glycerine suspension of the same drug. Of course, one must be certain that there is no important bronchial connection with any cavity in which this solution is employed.

The patient is now apparently well. He is working regularly and leads a normal life. About a year ago alopecia areata appeared and the hairline condition is now general. Its cause is unknown.

## TUBERCULOSIS OF THE LUNGS. PARAVERTEBRAL THORACOPLASTY.

DOCTOR LILIENTHAL presented a girl, aged sixteen years, who was sent to him November 5, 1928. For a year and a half she had had cough with positive expectoration. For seven months artificial pneumothorax had been employed; then adhesions occurred and fluid exudate appeared. There had

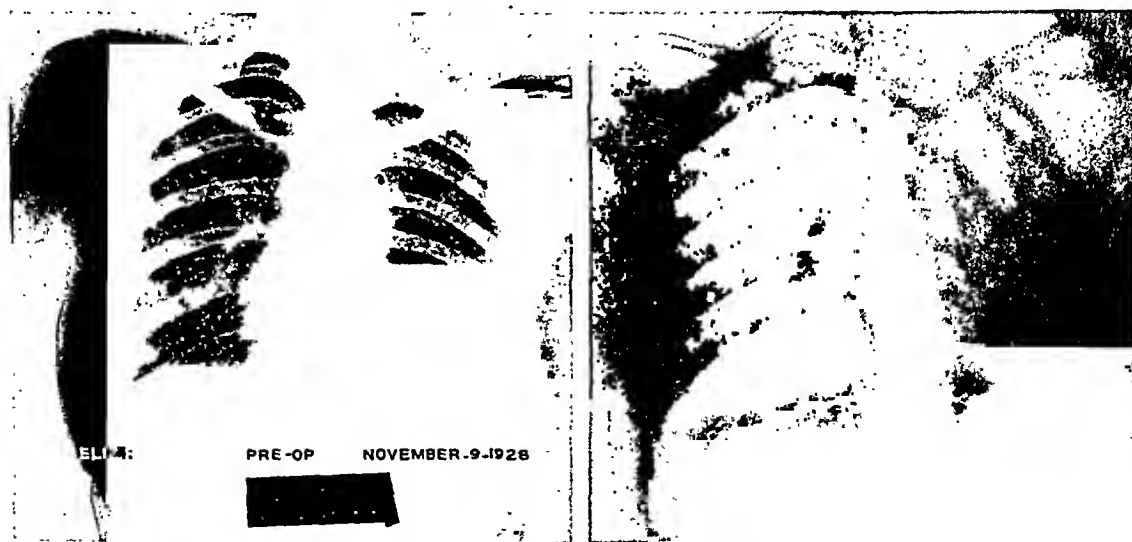


FIG. 3.—Case of a young girl. Tuberculous left lung with pyopneumothorax preoperative.

FIG. 4.—Same patient as Fig. 3. Post-operative, Bucky's Diaphragm.

never been hemoptysis. She was well nourished. Blood pressure was 110 over 65. Vital capacity 1.2. Weight 118 pounds. X-ray pictures demonstrated a fibrocavernous left lung with retraction of the mediastinum and diaphragm, and a large amount of pleural air and fluid. Thoracoplasty was advised preceded by phrenic neurectomy.

On November 17, 1928, the reporter operated at Mt. Sinai Hospital. For the first time in his experience he failed to find the phrenic nerve, although an extensive dissection was made even to the separation of the fibres of the anterior scalene muscle. November 27, 1928, the upper six ribs were resected. A silk thread marker was placed around the seventh rib to be used for orientation at the time of the second stage operation. This was done December 3, 1928, in local anæsthesia, supplemented by a very little nitrous oxide and oxygen. The seventh, eighth and ninth ribs were resected, about three to four inches being removed subperiosteally. After this operation, although the patient did well, the fluid and air within the chest prevented



a satisfactory collapse. It was difficult to reach either air or fluid with an ordinary needle of large size, but the next day, by inverting the patient and turning her upon the diseased side, it was able to aspirate about ten ounces of thick pus through a puncture just below the axilla. The patient then went home to come to the hospital as an ambulant patient. There again, the patient lying upon the *right* (well) side, in slight Trendelenburg posture, a tiny incision was made in the axillary line at a level just above the nipple and the air chamber was entered with an aspirating needle. It was then possible to insert a small trocar and canula, and the patient was turned so that this puncture was lowermost. Six ounces of moderately thick pus were aspirated with natural air replacement. Examination by the bacteriological department of the laboratory showed the presence of pneumococcus. About 1 dram of one per cent. mercurochrome was injected and the canula, previously filled with alcohol to prevent chest wall abscess, was removed. At this time there seemed to be an extension into the opposite lung and the prognosis was

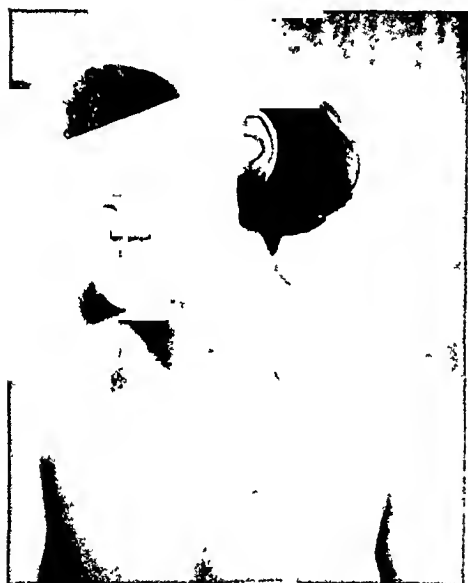


FIG. 5.—A phrenic neurectomy. Operative scar had to be drawn in by photographer; it did not show on the film. Same patient as Fig. 3.



FIG. 6.—Same patient as Fig. 3. Showing scar of thoracoplasty and function of arms.

not favorable, but with repeated aspirations by her attending physician, Doctor Blowstein, the condition improved both clinically and on physical examination; so that when she reported November 7, 1929, she was apparently convalescent. Although there is sputum in the morning (about 8 cubic centimetres) there is no fever and no cough. She has gained in weight and superficially she seems healthy. Vital capacity 1.6.

The favorable immediate result in a case of this kind, the patient in early youth with apparent extension to the opposite lung after the thoracoplasty, is most unusual and gratifying. It is also remarkable that the pyopneumothorax has disappeared. X-ray pictures now seem to show an elongated area of moderate size which resembles a cavity, but since there is almost no expectoration there may be another interpretation of this rarefaction shown in the film.

DOCTOR LILIENTHAL presented also a man, now thirty-eight years old, who came under observation as an emergency situation April 7, 1928. He had been suffering from pulmonary tuberculosis for about fifteen years. Pneumothorax

therapy left lung was begun about thirteen years ago. He did very well under this treatment and was apparently cured of the tuberculosis. About three years ago the first evidence of a purulent effusion in the left chest appeared. Treatment by aspiration was employed. An abscess developed over the left posterior chest. This was incised and the sinus drained profusely for several months. About six months before the patient first came under the reporter's observation there was the onset of irregular fever with profuse, foul, purulent expectoration. These manifestations continued with remissions until three weeks before his hospital admission. Since then the clinical course has been rapidly downhill, with severe pain in the left chest on coughing; profuse, foul expectoration; high, irregular fever; and rapid emaciation.

On physical examination the striking features were the anxious expression, pronounced pallor, and septic appearance. There was obvious emaciation. The left chest was narrow as compared with the right, was completely flat on percussion, and breath sounds were faint. There was a sinus over the posterior aspect of the left lower chest into which lipiodol was introduced. The X-ray plate of the chest revealed a collection of fluid filling almost the entire left lower cavity. It presented a horizontal level situated at the second interspace anteriorly. Above the fluid level there was a collection of air. The collapsed lung could not be identified. The heart was greatly displaced to the right.

Operation was done under gas, oxygen anæsthesia. A free incision was made through the sinus over the left posterior chest and carried upwards to the level of the third rib. Long sections of the third to ninth ribs were removed together with intercostal tissues and the greatly thickened, fibrous parietal membrane over the empyema. An enormous quantity of exceedingly foul-smelling pus was evacuated. The lung was found crowded up to the apex and its surface was covered by the same, thick, necrotic membrane that lined the remainder of the pleural cavity. The purpose of this wide resection of the chest wall posteriorly was to open up to its fullest limits the pleural infection assumed to be complicated by contamination with an anærobic organism. The parietal membrane was excised for freer drainage and in the hope of obtaining at least partial later obliteration of the cavity. The wound was widely drained. On the third day after operation temperature rose to 105 and the patient's condition became critical, but temperature subsided after that time and the general condition began to improve. Cough and expectoration rapidly subsided.

Ten days after operation blood transfusion was given in order to improve the general condition. There was progressive increase in weight and strength and the patient was in satisfactory condition on his readmission to the hospital for a second operation one month after the first. At that time the purpose was to resect the anterior and superior part of the wall of the empyema cavity. Under gas, oxygen anæsthesia a long incision was made from the anterior axillary region downwards. The scapula was mobilized by severance of some of its musculature and was drawn backwards. The empyema cavity, now clean and empty, was entered and resection of ribs, intercostal tissues, and the entire parietal membrane was begun from below upwards. Long sections of the third to ninth ribs were removed. The anterior limits being the anterior limit of the empyema cavity and in each instance the rib was completely removed through its old posterior limit; in other words the entire thoracic cage was removed over the full limits of the empyema. The wound was closed in layers and a tube left in the old posterior drainage wound. The man did very well after operation. There

was a moderate amount of purulent discharge from the cavity, adequately cared for by irrigation.

After leaving the hospital progressive improvement in the general condition continued. There has never been any recurrence of cough or sputum. The patient has gained much in weight (65 pounds). He is symptom free. X-ray check-up of the chest showed at first a fairly wide empyema cavity. This has progressively reduced in size so that now a narrow chink remains. As a safety valve this is being kept open by a drainage tube. From the cavity there is an escape of small amounts of mucoid material sometimes admixed with pus. Doctor Neuhof thought it unwise to permit this cavity to close and proposes to continue with the drainage tube unless the discharge completely ceases.

#### TUBERCULOUS EMPYEMA WITH COMPLICATING PNEUMOTHORAX.

DR. HAROLD NEUHOF presented a man, now forty-eight years old, who first came under observation in June, 1927, with the history that he had been under treatment for pulmonary tuberculosis for eight years. After one year's illness pneumothorax therapy was begun for a widespread right sided pulmonary tuberculosis. This treatment was continued for many months. Excellent collapse was obtained, fibrosis of the right lung resulted, sputum became progressively more and more scanty, and has remained free from tubercle bacilli. Other than some discomfort on the right side of the chest the patient was symptom free until 1925. At that time there was a sudden attack of coughing accompanied by expectoration of a considerable quantity of pus. Purulent expectoration in varying quantities continued. About six months before the reporter first saw him the patient began to lose flesh and strength and the expectoration became progressively more profuse. There was fever from time to time. The patient finally had to remain in bed most of the time because of weakness and could not lie on his left side because expectoration of large quantities of pus and a choking sensation would follow directly upon the assumption of that posture. There was pronounced emaciation, moderate dyspnoea. He was constantly coughing with the expectoration of thick, purulent sputum. Examination of the chest disclosed advanced contraction of the right side with complete immobility. The percussion note was flat and respiratory sounds were almost inaudible. The X-ray picture was that of a dense, homogeneous shadow occupying the contracted right chest with the heart and the mediastinum partly drawn to that side.

The first operation, performed in June, 1927, under local anaesthesia, consisted in a free incision made over the posterior part of the right axilla. Two ribs were widely resected. The dense parietal membrane was aspirated and pus obtained. Plan was to attempt an obliteration of at least part of the empyema cavity. Accordingly the parietal membrane was widely stripped away to make a large extra-pleural dead space. Into this was turned large mobilized flaps of the latissimus dorsi and pectoralis major muscles. The skin was closed without drainage. The immediate post-operative course was satisfactory. Coughing and sputum rapidly subsided and were absent at the time of discharge from the hospital, one month after operation.

The patient was readmitted two months later with the history that he had been doing well for about a month. He then began to have recurrence of cough and purulent expectoration; the symptoms not being quite as severe as before operation. A small sinus had appeared in the wound and from this there was some discharge of pus. It was found to enter the empyema cavity

## TUBERCULOUS EMPYEMA WITH COMPLICATING PNEUMOTHORAX

and lipiodol was introduced. The cavity was found to be reduced in size and communicated freely at its dome with the bronchial tree.

At operation the plan was to attempt more complete narrowing of the empyema cavity and it was thought in order to accomplish this the parietal membrane, as well as overlying ribs, would have to be removed. Under local anæsthesia a large "S" shaped incision was made through the right axilla. The pectoralis major and minor muscles were severed, freely exposing the second and third ribs. These were widely removed together with the intercostal tissues. The greatly thickened, infiltrated parietal membrane was excised over most of the empyema cavity. The cavity itself was entered at one point. For the most part, thin layer of pleura was all that was left over the parietal aspect of the empyema. The severed musculature was turned into the dead space and skin closed and a compression bandage applied. The immediate post-operative course was stormy—with fever, listlessness, and rapid, and feeble heart action. A definite interpretation of these phenomena was not made, but it was assumed that a quiescent tuberculosis had been lit up. Improvement began about the tenth day after operation and continued slowly. One month after operation the patient was convalescent with healed wound, showing depression of that part of the chest wall. There was very little cough and sputum.

After leaving the hospital the patient's condition progressively improved. It is now two years since the operation. There has been steady gain in strength and return of weight to that before the present illness began. There has been no cough or sputum since the time he left the hospital two years ago. X-ray check-ups show the pronounced narrowing of the chest wall in the operative field and a small remaining pneumothorax. This collection of air appears to be in process of gradual absorption and therefore adds, I believe, to the desired shrinking defect on the walls of the empyema.

DR. JAMES ALEXANDER MILLER said that from the standpoint of the early high mortality in Doctor Lambert's presentation, he felt he deserved a large share of the responsibility. In his anxiety to do everything possible for the patient he had urged Doctor Lambert to take risks he might otherwise not have done. In those early years the limitations of these operations were not known as they are today. This was not a fair test of the value of any new method of surgery. At the present time, internists are very conservative in selecting these patients for operation, letting those to whom surgery does not offer reasonably good chances go on the best they can without it.

This question of selection is very important from two aspects. First: The condition of the opposite lung, not only as regards the presence of tuberculosis, but its character and position and how it has behaved over a period of observation, whether quiescent or active or reasonably active. Second: The general condition of the patient. In tuberculosis we can afford to use a good deal of time to get the patient in shape for operation. If we can hold before them the promise of surgical relief we can often persuade them to take a strict rest cure and adapt themselves to proper environment so that instead of operating on them as an emergency when they are going downward, we will wait until they are on the upward grade.

Doctor Miller stressed another point, from the standpoint of the internist, and that was to beg the surgeons to do as little as possible in the way of

interference, which would involve the tuberculous tissue itself; also to divide the operation with several stages. It is better to take four or five chances in as many stages than to take too big a chance at once.

Last of all, he emphasized that these operations, as Doctor Lambert had brought out, are simply an incident in the treatment of a chronic disease; and that before the operation and during the stages of operation and after the operation, for a long time, for months and years they have tuberculosis for which they must be treated along definite conservative lines. If operation gives them freedom from local symptoms, from symptoms of active disease, then careful nutrition will increase their resistance and after a time enable them to take up an active life; become, in other words; arrested cases. Doctor Lambert and other surgeons use the word "cured"; in two years to four years they are considered cured. This, internists never do; after four or five years' freedom from symptoms they are still considered only apparently cured. There has been too much preaching about the curability of tuberculosis. It is a great mistake to forget that they may relapse under unfavorable conditions. No surgeon should take the responsibility of treating them without the coöperation of an internist skilled in their general management.

DOCTOR HOWARD LILIENTHAL agreed with Doctor Lambert that surgical operations upon the chest, intended to arrest or bring symptomatic relief in pulmonary tuberculosis, are justifiable when medical and hygienic treatment have failed, and when artificial pneumothorax has been unsuccessfully carried out or has been impossible to induce. In many cases the production of unilateral phrenic paralysis, temporary or permanent, should precede the direct attack upon the chest and it should sometimes take precedence over artificial pneumothorax.

Thoracic operations are of various types and must be selected according to the case in hand. Multiple procedures at intervals are nearly always required and the proper selection of type and extent is probably the most important function of the surgeon. Nearly anyone may quickly acquire technic, but good judgment is either innate or is one of the rewards of experience. Too often the physician assumes that there is *an* operation for pulmonary phthisis and that this is the now well-known paravertebral thoracoplasty of Sauerbruch. The surgeon should correct this impression, and the patient as well as the doctor, should be made to understand that the objective, clinical cure is only rarely attained by a single operation.

With regard to the usual form of thoracoplasty, the cases suitable for this treatment may be divided into two great classes: (*a*) Without the complication of purulent pleuritis; (*b*) Those with empyema in addition to the pulmonary disease. There is also a rare form of tuberculous empyema in which the lungs are apparently unaffected.

Regarding cases uncomplicated by empyema: First, there are those in which there is a favorable outlook as to improvement or clinical cure by operation. These are usually of the fibro-cavernous variety in which there

has been slow progress and with the cavities small in size. Second, the cases with great cavitation, usually apical, in which there has been unwarranted delay in spite of the steady advance of the lesion. Even here clinical cure, though less likely to be secured, is possible provided the condition of the contra-lateral lung is satisfactory and has remained stationary during two months, more or less, of observation.

Sometimes it is not the tuberculosis from which the patient is suffering, but some disturbance which may have been brought about by the healing process itself; *e.g.*, respiratory or cardiac distress from deviation of the mediastinum, due to contraction and adhesions. Patients have been seen with tremendous distorsion of the trachea and displacement of the heart toward the healed side, who were unable to make the slightest physical exertion without great dyspnoea. Complete relief followed thoracoplasty which permitted the heart and other mediastinal structures to assume more normal relations. In spite of having been helpless and bedridden, one of Doctor Lilienthal's patients, for years after the operation, was able to do her own housework and even tend her little garden.

*Statistics.*—Statistics are valuable in proportion to the number of their component units. A study of percentages in, say, one thousand cases is more apt to be convincing than one in which the results are culled from only a hundred. Add to the sources of error the element of the many individual operators with their varying personal equations and the unreliability of conclusions becomes very evident.

The possibility of error in estimating the cause of death and its relation to operation must be, in the last analysis, a matter of opinion, and all that one can ask is strict conscientiousness in making reports. To exemplify:—Œdema of the opposite lung within twenty-four hours was probably the result of the operation. A sudden and rapid extension of the disease may, or may not, have been produced by the operation. Hemoptysis is rarely the result of thoracoplasty and it may, of course, arise from either side of the chest. It is quite possible that massive atelectasis may have caused post-operative death.

It is obviously unfair to set a limit of post-operative time within which some untoward phenomenon—or even death—is to be ascribed to the operation. For example, if ninety days is the period set and the patient steadily deteriorates and dies on the ninety-first day, the case should not fairly be regarded as an example of unsuccessful surgery; while suicide or an unrelated accident on the eighty-ninth day, when the patient seemed to be doing well, ought not to be counted as an operative fatality.

*Personal Experiences.*—In his own work Doctor Lilienthal has not refused to operate in any case referred by a competent phthisiologist, no matter how unpromising the outlook provided, only, that the patient was not moribund, and provided also that the opposite lung presented sufficient functioning power to maintain life. Complications of cardiac, renal, intestinal or laryngeal disease not certainly of themselves fatal, did not deter him. The

mortality rate was high (24.4 per cent.) but was limited in all but two cases out of ten, to apparently doomed individuals. While most—not all—of the successful results were in those who seemed to have but a few months or even weeks to live. It was worth while.

There have been but three unexpected deaths; one from post-operative oedema of the opposite lung; one from undiagnosed diffuse tuberculosis of the opposite lung; one from causes which, in the absence of a post-mortem examination, could not be explained. In counting the deaths no time has been set, and this, of course, is not exactly fair, for some of the patients died many months, and others even years, after their thoracoplasty. He planned to publish later a full statistical report with all its opportunities for false conclusions.

DR. HAROLD NEUHOF said that at Montefiore Hospital the cases in which thoracoplasty might be indicated for pulmonary tuberculosis were carefully sifted and that only apparently favorable cases were referred to him for operation. Accordingly, these were cases in which there was an obvious effort towards contraction on the side of the disease, with fibrosis of the lung, narrowing of the intercostal spaces and drawing of the mediastinum and heart to the affected side. They were cases of long standing in which such suggested indications for operation as repeated hæmorrhage, profuse sputum, or long continued rise of temperature existed. As a result of this careful selection of material, the number of operated cases was relatively small and the mortality was naturally lower than in the figures presented in the paper of the evening. It is, of course, an open question whether operation should be limited to this favorable group of cases. In them, however, a clearer impression of the prognosis can be had. Even in this group of cases the results have been variable. There have been cases in which a satisfactory outcome had been anticipated and in which it did not occur. The opposite also holds true, for there have been some instances in which operation did not appear to promise much of a result and in which satisfactory end results have been noted. There seems to be an intangible factor that cannot be influenced by the mechanical result of the collapse of the chest wall. It may be that it is dependent upon the difference in the behavior of the tuberculous process in different individuals.

# BRIEF COMMUNICATIONS

## GIANT URETERAL CALCULI\*

THIS case is reported (1) as a freak of rare occurrence; (2) to illustrate the value of a two-step nephrectomy.

Reshower, in 1927, reported a case of stone in the lower third of the left ureter in a female tripara measuring twelve centimetres in length, without symptoms on the left side, accompanied by a small stone in the right ureter which produced severe paroxysmal pains on the right side, and states that "no ureteral stone nearly its size has been reported."

Young mentions one about the size of a small cigar.

*Two-step Nephrectomies.*—There have been two distinct surgical operations advocated for two-step nephrectomy. One, trans-abdominal ligation of renal vessels as suggested by Walker, Holt, Kellock, Quinby, Eisendrath and others to reduce the technical difficulties of nephrectomy or prevent metastases from renal tumors. Two, nephrostomy is done for

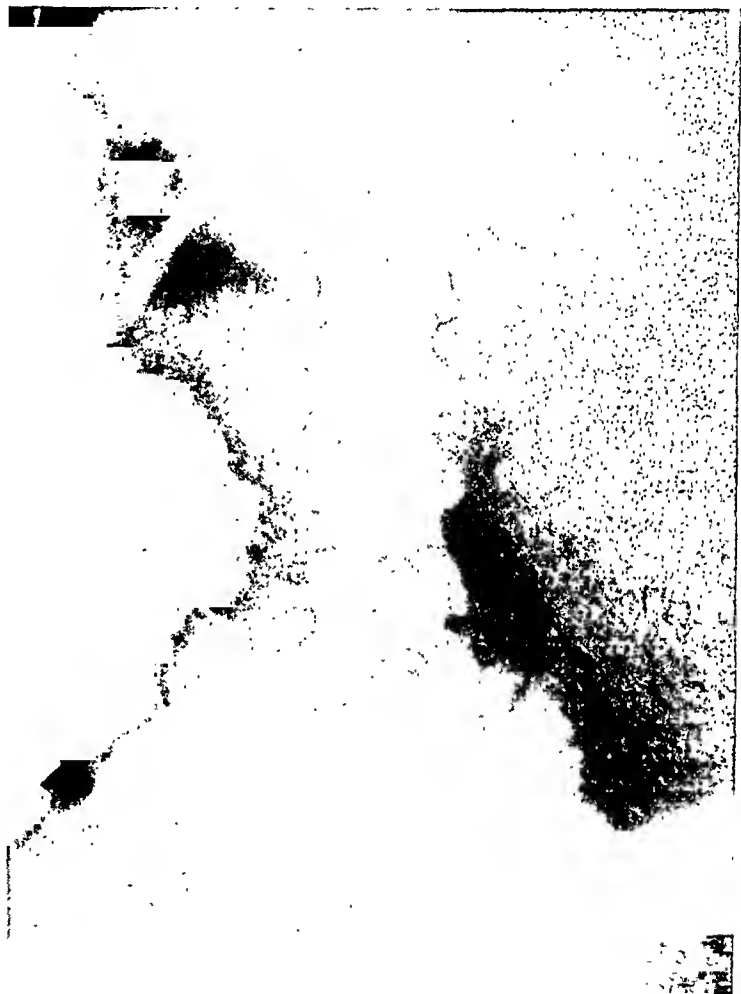


FIG. 1.—Röntgenogram showing large calculi in left ureter and large left kidney.

drainage, as recommended by Chute Caulk, Bugbee, Cahill, Alcock and Crosbie.

In 1920 Chute reported twenty cases (with two deaths—one, tuberculosis; one perinephritic abscess) of secondary nephrectomy, nine of which the operation was intentional and eleven cases where the operation was forced upon the operator, either by difficulties arising at the time of operation, or by error of some sort, either in diagnosis or judgment.

\* Read before the Wisconsin Urological Society, April 12, 1929.



Alcock, in 1925, reported seventeen cases of two-step nephrectomy, ten of which were intentional.

Two-step nephrectomy is not to be recommended as a routine procedure; it is a life-saving operation in the poor risk patient, who is toxic from a suppurating kidney. In such cases preliminary drainage allows the patient to rid himself of his sepsis before nephrectomy is attempted.

**CASE.**—J. A. R., white, male, eighteen years of age. Referred by Dr. H. C. Schumm, January 24, 1927. History of tonsillectomy four years ago for recurrent attacks of follicular tonsillitis.

**Present Illness.**—One month ago complained of pain over left kidney which radiated down along left ureter and to left thigh. Treated by family physician for three weeks. When first seen had

FIG 2—Röntgenogram showing two large calculi in left ureter.

a temperature of  $103^{\circ}$ , pulse 100, and respirations 20. There was a large palpable mass in the left upper quadrant of the abdomen, painful on pressure, with muscle spasm in the left costovertebral angle. Urine—pus. He was admitted to Columbia Hospital January 31, 1927. Temperature  $104.2^{\circ}$ , pulse 100, respirations 18. Cystoscopic examination February 1, 1927. Gas æsthesia.

A No. 6 X-ray catheter was passed up the right ureter to the kidney pelvis with ease, and clear urine was obtained in drops. Pus was seen coming from the left ureteral orifice. A No. 6 X-ray catheter was passed up left ureter one centimetre, at which point obstruction was met. Filiforms could not be passed. Röntgenogram showed a large shadow

in the left ureter just above the bladder with a very large left kidney. (Figs. 1 and 2.)

**Diagnosis.**—Large ureteral calculi (2), left; with ureteral dilatation and pyonephrosis, left.

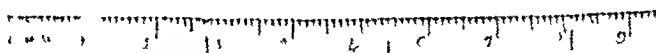
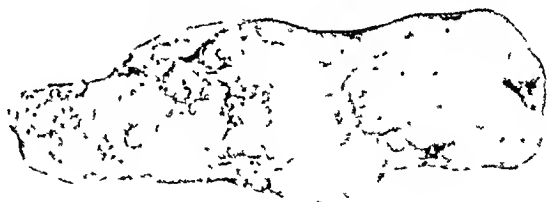


FIG 3—Two large calculi removed from left ureter.

## GIANT URETERAL CALCULI

*Laboratory Findings.*—January 31, 1927. White blood cells 19,000, red blood cells 4,770,000, hæmoglobin 80 per cent., polymorphonuclears 75.5, small leucocytes 3.5, large leucocytes 2.5, transitionals 14.5, eosinophiles 3.5, basophiles 5, platelets normal. March 15, 1927. White blood cells 16,000.

*Blood Chemistry.*—February 1, 1927. Non-proteid nitrogen 37 milligrams per 100 cubic centimetres of blood. Urea 37.4 milligrams per 100 cubic centimetres of blood. Urea nitrogen 17.4 milligrams per 100 cubic centimetres of blood.

February 1, 1927.—Blood culture negative after forty-eight hours of incubation.

February 1, 1927.—*Urine:* right—negative, left—pus. *Culture:* Many small Gram-negative bacilli; few Gram-positive cocci.

*Phenolsulphonaphthalein Test.*—February 1, 1927. *Right:* Appearance time three and one-half minutes, 15 per cent. elimination in fifteen minutes. *Left:* No trace in thirty minutes. February 24, 1927. *Right:* Appearance time three minutes, 15 per cent. eliminated in fifteen minutes. *Left:* No dye in thirty minutes (from ureter or nephrostomy wound). March 25, 1927. Appearance time two and one-half minutes, 18 per cent. eliminated in fifteen minutes. April 6, 1929. Appearance time three minutes, 25 per cent. eliminated in fifteen minutes.

February 14, 1927.—Ureteral calculi (1) measured 11 by 3.6 centimetres; (2) measured 7 by 1.5 centimetres. Weight together fifty grams, chemical examination gave calcium and magnesium phosphate reactions.

*First Operation.*—February 2, 1927. Nephrostomy. One thousand cubic centimetres of pus, temperature 103°, pulse 100, respirations 22.



FIG. 4.—Left kidney after nephrostomy, showing pyonephrosis and marked contraction.

*Second Operation.*—Feb-

ruary 9, 1927. Ureterolithotomy, left, temperature 99°, pulse 92, respirations 20. (Two large calculi, Fig. 3.)

*Third Operation.*—February 25, 1927. Nephrectomy. (Fig. 4.) Temperature 99.2°, pulse 88, respirations 20.

*Fourth Operation.*—June 18, 1927. Ureterectomy, left. Temperature 98.4°, pulse 80, respirations 18.

At the time of the nephrostomy he was a very poor operative risk. Convalescence was fair and one week later two large stones were removed from the lower end of the left ureter, after which he continued to improve, with the urine containing a large amount of pus and moderate drainage from nephrostomy wound. February 24, 1927, or twenty-two days after the first operation, no function could be demonstrated from the left kidney and nephrectomy was recommended. After nephrectomy his general condition gradually improved, with the urine containing pus continuously and the temperature varied from 97 to 99.4°.

At cystoscopical examination June 16, 1927, pus was aspirated from the left ureter, hence ureterectomy was decided upon, after which convalescence was uneventful.

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## TRANSPLANTATION OF A BILIARY FISTULOUS TRACT INTO THE DUODENUM

ACCORDING to his bibliography which is appended to this article, Hugh Williams was the first surgeon to anastomose a biliary fistulous tract to the duodenum.<sup>1</sup> This patient is reported well sixteen years following this operation, which indicates that biliary fistulous tracts, after draining to the surface for a more or less prolonged period, will remain permanently patent. Similar experiences have been reported by Lahey,<sup>2,3</sup> Lilienthal,<sup>4</sup> Masson,<sup>5</sup> F. B. St. John,<sup>6</sup> and Walters.<sup>7</sup> It is well known that biliary fistulous tracts, with an obstruction in the common duct, and also duodenal fistulous tracts, remain patent for an indefinite period which is often long enough to produce a serious loss of essential substances from the alimentary tract. The cause for the prolonged patency of these fistulæ is generally assumed to be due to the nature of the secretions transmitted. This suggests that when a common duct is destroyed or becomes useless, and can in no way be joined to the small intestine, a permanently patent biliary fistulous tract may be purposely formed, from the ducts above the obstruction, by prolonged drainage around a rubber tube; and after a few months' duration a transplantation of this newly formed channel may be made into the duodenum. In the case I am reporting I found the tract to be lined by many gland-like structures resembling intestinal mucous membrane. This is a desirable formation if the tract is to be transplanted as these glands will undoubtedly assist in keeping the lumen of the tract patent.

**CASE REPORT.**—This patient was a married woman, aged 38 years, with a previously negative history. In November, 1928, her gall-bladder and appendix were removed elsewhere, which operation was followed by a biliary fistula about seven days later. Two months after the first operation an attempt, elsewhere, was made to close the fistula by joining the amputated common duct to the duodenum. A few days later the patient became jaundiced and developed signs of peritonitis. The wound was then opened and a small rubber drainage tube was inserted down to the area of the last operation, which left a fistula draining duodenal contents and bile up to the time I first saw this patient in March, 1929. At this time she had lost fifty pounds and was confined to bed owing to extreme weakness.

For an area of about ten centimetres around the fistulous opening the epidermis

had been destroyed by the digestive juices, and the pelvic cavity contained about 2000 cubic centimetres of a thick bile-stained fluid which was contaminated by colors bacilli. The extreme weakness of the patient demanded fresh blood, several transfusions of which proved to be of the greatest benefit. Following the blood transfusions the pelvis was drained through a McBurney incision. The skin around the fistulous tract was completely healed over in two weeks by new skin through the use of saturated sodium bicarbonate solutions applied on gauze very frequently during the day and night. The use of dilute hydrochloric acid solutions containing proteins was tried at first, but they had only a moderate degree of healing or neutralizing effect over the pancreatic secretions. The patient was given 30 grains of sodium bicarbonate with 2 grains of magnesium oxide one hour after each feeding, which may have been of some assistance to the sodium bicarbonate solutions externally.

About eight weeks after entering the hospital and with supportive treatment, this patient had almost regained her normal blood chemistry, and appeared in a condition for an exploration of the fistulous tract, with the idea of joining it to the duodenum if possible. About five centimetres below the peritoneal layer of the incision the tract divided into two channels (Fig. 1), one going into the duodenum and the other continuing upward into the common duct.

The normal end of the common duct seemed to

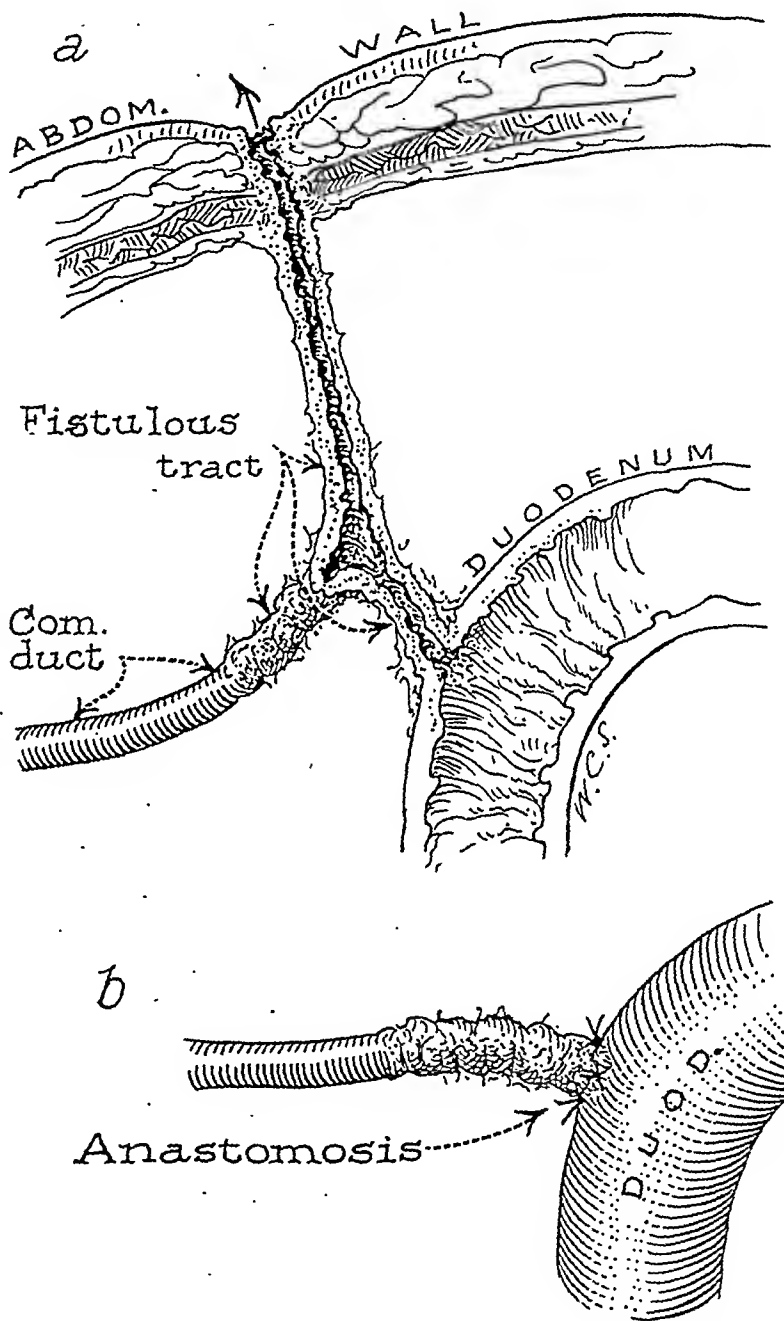


FIG. 1.—Side view of the fistulous tract draining the common bile duct and the duodenum.

be separated from the duodenum for a distance of about 7 centimetres. The fistulous tract was cut free from the duodenum and abdominal wall and then joined to the duodenum as in Figure 1, with 00 chromicized catgut. The recovery was uneventful, the patient gaining weight and strength rapidly and four months after the operation, she was in perfect health, having gained fifty pounds.

Cross sections of the tract where the biliary and pancreatic segments joined,

showed the inner layer to consist of columnar epithelium in circumscribed areas. Many gland-like structures, the origin of which could not be determined, were found beneath the inner surface. These gland-like structures and areas of columnar epithelium resembled more the mucosa of the duodenum than the mucosa of the common duct. Their presence quite likely accounts for the tendency of these fistulous tracts to remain patent and drain biliary and duodenal secretions. Perhaps in time this inner layer would be similar in structure to the intestinal mucous membrane. Figure 2 is a photomicrograph of a cross section of the fistulous tract at about 1 centimetre



FIG. 2.—A cross section of the biliary-duodenal fistula taken just above the junction of the two tracts.

beyond the junction of the two segments draining the common duct and the duodenum. Through a misunderstanding, the desirable stained sections were destroyed and the undesirable specimens were kept intact. This accounts for the poor illustration in Figure 2. In the better sections I found the lumen to be well shown and surrounded by gland-like structures evaginating from a mucous membrane-like surface.

#### COMMENT

It is suggested that when necessity arises biliary and duodenal fistulous tracts may be purposely formed by prolonged rubber tube drainage, with the aid of supportive blood and alimentary tract chemistry, and later anastomosed to the intestine. The demonstration of glands in great numbers evaginating from the inner surface of the fistulous tract suggests a probable reason why these duodenal and biliary tracts fail to close before transplantation as well as remain patent following their anastomosis to the intestine. The presence of columnar epithelium and gland-like structures in these fistulous tracts and at a considerable distance from the mucosa of the common duct and duodenum demonstrates the proliferative powers of alimentary tract epithelium. It offers a similar example to the proliferative tendency of uterine mucosa. This report demonstrates the value of saturated sodium bicarbonate solutions

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in the healing of skin denuded by pancreatic secretions. Dressings of such strong alkaline solutions seem to inhibit the activity of the pancreatic solutions as well or better than the acid solutions with or without proteins.

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## CONGENITAL ABSENCE OF THE NECK OF THE FEMUR \*

CONGENITAL absence of the neck of the femur is a comparatively rare anomaly and seldom enters into the differential diagnosis of congenital dislocation of the hip. However, this condition along with post-infective and post-paralytic dislocations and coxa vara, presents a similar clinical picture on cursory inspection, varying only in degree of deformity.

The history of a painless sinking limp, first noticeable when the child begins to walk, suggests the likelihood of a congenital dislocation of the hip. The usual confirmatory clinical features are the shortening of the limb, the upward displacement of the trochanter, the absence of the head from its normal position below the centre of the inguinal ligament and mild limitation of abduction with the other movements comparatively free. A positive Trendelenburg with elevation of the gluteal fold, gluteal fullness and lordosis are further points in evidence, and yet these clinical features are all demonstrable in cases of congenital absence of the neck of the femur. However, the comparative rarity of this anomaly prevents it from masking a congenital dislocation of the hip.

The cases on record of this condition are few and the purpose of this paper is to introduce one other case report. Robert Alph<sup>1</sup> in 1851 reported a case of bilateral congenital absence; Anger<sup>2</sup> in 1864 a unilateral case; Frieberg<sup>3</sup> in 1906 reported a case in a fifteen-year-old chondrodystrophic dwarf. Ridlon<sup>4</sup> in 1909 reported a bilateral case, and Thomas<sup>5</sup> added one seen in 1911 at the age of two that failed to develop normal necks. Perrin<sup>6</sup> in 1913 referred to Duhmann's theoretical classification of congenital malformations of the femur: 1. Diminution in development of the upper epiphysis. 2. Ab-

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sence of the upper epiphysis. 3. Absence of the upper epiphysis and diaphysis; and described a case of extensive arrest of development of the femur. Kidd<sup>7</sup> in 1911 described a case that would fall in the third of the above classification, in which the upper epiphysis and part of the shaft was lacking. Stone, Bloom and Huricques<sup>8</sup> in 1917 reported a case of congenital absence of the lower femoral epiphysis. Scaudto<sup>9</sup> in 1923, discovered by X-ray, in a child of five years, a unilateral absence of the entire upper epiphyseal nucleus and the neck of the femur. Nilsonne<sup>10</sup> described two

cases that in infancy apparently had congenital defects of the upper femoral epiphysis which later showed coxa vara. Peabody<sup>11</sup> recently reported a case of bilateral defect of the femoral heads in a girl of twenty-three years. This apparently is the only adult case on record.

Cohn,<sup>12</sup> in reviewing the literature, arrives at conclusions that were borne out by his own studies on epiphyseal centres and their subsequent ossification. There are three epiphyses for the upper end of the femur, one each, for the head, the greater and the lesser trochanters. The epiphysis for the head makes its appearance during the second half of the



FIG. 1—Röntgenogram taken at time of admission showing the agenesis of the neck of the femur.

first year and is completely ossified during the sixteenth and eighteenth years. The epiphysis for the greater trochanter appears at the fifth year and ossifies during the fifteenth and sixteenth years. There is a bony prominence at the junction of the shaft and neck on the inner aspect of the femur which is probably the lesser trochanter. However, this prominence is definitely a portion of the shaft and not a separate epiphysis. At about the ninth year a separate scale-like epiphysis appears over the bony prominence which is completely ossified and united with the shaft during the sixteenth year. The neck of the femur is an upward growth from the shaft, a true process of extension *per se* which during the second year of life forms an obtuse angle expansion from the

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upper portion of the shaft. It grows as a part of the shaft and is surrounded by three epiphyses, one for each trochanter and one for the head which eventually fits over it like a cap.

CASE REPORT: D. J. K., No. E 42. Service of LeRoy C. Abbott, the Shriners' Hospital for Crippled Children.

Admitted March 13, 1928. A female of five years with an irrelevant family history, who was the first child of youthful parents and a breech delivery. Some shortening of the right leg was noted at birth by the attending obstetrician, though this gradually became more pronounced. She walked at ten months with considerable limp, using her right foot hyperextended to accommodate because of her short extremity. It was possible for her to walk with her right foot at right angles, though this was very awkward because of the resultant pelvic tilt. Her general physical examination was negative except of her undersize and infected tonsils. She was 40.25 inches in height and weighed 32 pounds. She had the classical signs and symptoms of a congenital dislocated hip and was so diagnosed on several occasions before her admission. Her left leg was 19.5 inches long and her right 15 inches long. (A. S. S.-I., M.) Her right tibia measured 8 inches in length and the distance from her right A. S. S. to her tibial tubercle was 7 inches. X-rays of the pelvis were made and the report was as follows:

Antero-posterior view of pelvis and lower extremities including knees. The bones

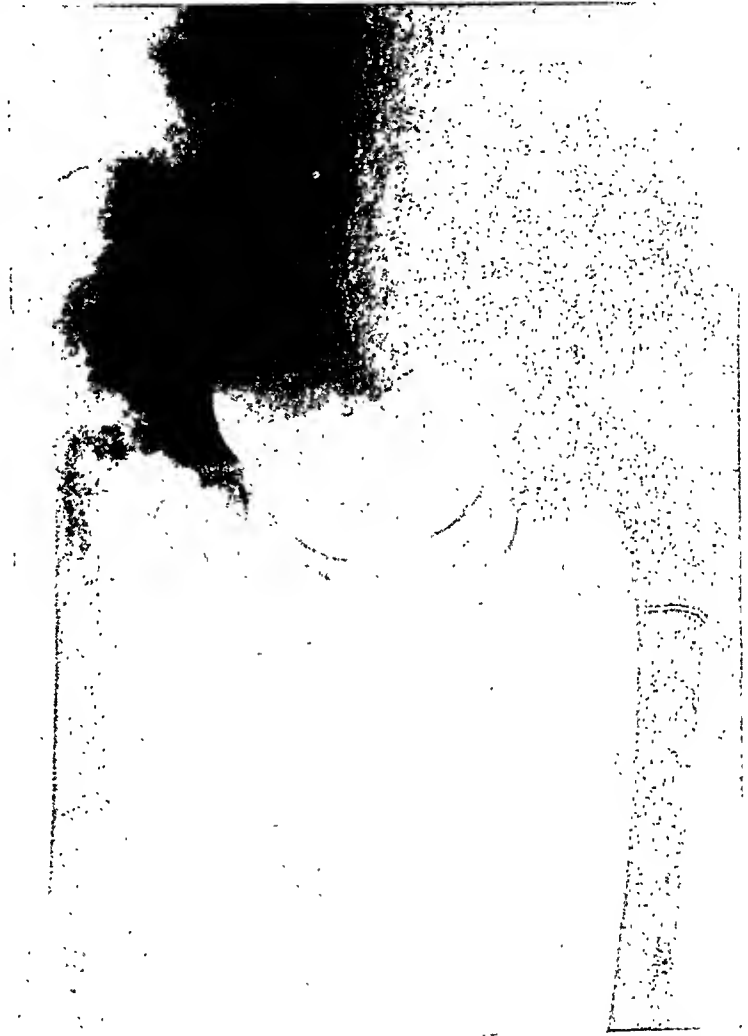


FIG. 2.—Köntgenogram illustrating the atrophy of the bones of the right lower extremity.

of the right lower extremity are relatively small and poorly developed as a result of less use than bones of opposite side. The right femur is approximately one-half the length of the left. This is due to the absence of a head, neck, trochanter, and approximately the upper third of the shaft of this bone. The nature of the bone indicates that the deficiency is of a congenital and not acquired origin, and though the upper extremity of this femur is bulbous, it does not have the characteristics of a femoral head and neck, even rudimentary. The upper end of this femur lies slightly above the level of acetabulum. X-ray Diagnosis. Agenesis of upper third of right femur.

On March 19, 1928, skeletal traction was instituted by means of a supracondylar Steinmann pin. The weight was increased by five pounds daily until thirty pounds was



employed. On April 7, 1928, X-ray revealed the upper end of the shaft to be opposite the acetabulum and the Steinmann pin was removed. On April 9, 1928, by means of a Smith-Peterson approach the hip-joint was opened. The head demonstrated in the X-ray was in the acetabulum and consisted almost entirely of cartilage. The shaft of the femur extended almost two inches above the level of the head. The neck of the femur was absent. Cartilage was removed from the upper end of the shaft and brought down to fit in the head in the shape of a ball and socket joint. The hip was fixed in an abduction spica. The sutures were removed June 12, 1929, and a similar spica reapplied. The patient was discharged July 24, 1928, to return in six weeks.

The avenues of speculation are certainly many in this instance. Can the sequence of events be traced in chronological order? The cartilagenous epiphyseal head of the femur is in its normal position as was shown by X-ray studies and confirmed by operation. There was no trace of a lesser trochanter as would be expected in a child of this age and the barest semblance of a greater trochanter. The question arises, when was the continuity of the femur broken, was there an early intrauterine separation of the epiphyseal head with subsequent upward displacement of the shaft? If this is true, perhaps the epiphyseal head plays a more important part in the formation of the neck of the femur than the röntgeneologists hold that it does. It is, however, safe to conclude that suppression of epiphyseal development in the upper end of the femur will result in absence of the neck.

## SUMMARY

A case of congenital absence of the neck of the femur is reported and the literature briefly reviewed, bringing the cases reported up to twelve.

The epiphyseal sites of the upper end of the femur are discussed and questions raised as to the importance of the epiphyseal head in the subsequent development of the neck of the femur.

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## IMPERFORATE ANUS WITH PERSISTENT CLOACAL DUCT

THE cases of Imperforate Anus are not so uncommon in medical literature, but the cases of a true cloaca persisting are extremely rare, and it is for this reason that we are reporting this case. During the early weeks of development of the embryo in utero, the entodermal cloaca pushes aside the mesoderm and approaches the surface, finally fusing. This area of fusion is known as the "Cloacal Membrane," which consists of two layers of entodermal and ectodermal. This membrane forms a septum between the cloaca and the urogenital fossa. The proliferation of the entoderm and mesoderm form the urorectal septum and this in turn divides the cloaca into the dorsal "rectal" and ventral "uro-genital." This is followed closely by the peritoneum forming the recto vesical cul de sac. Fusion of the urorectal septum with the cloacal membrane forms the perineum, and divides the membrane into urogenital sinus and rectum. If the urorectal membrane fails to close completely with the cloacal membrane, the cloacal duct persists and the rectum communicates with the urinary bladder (Fig.

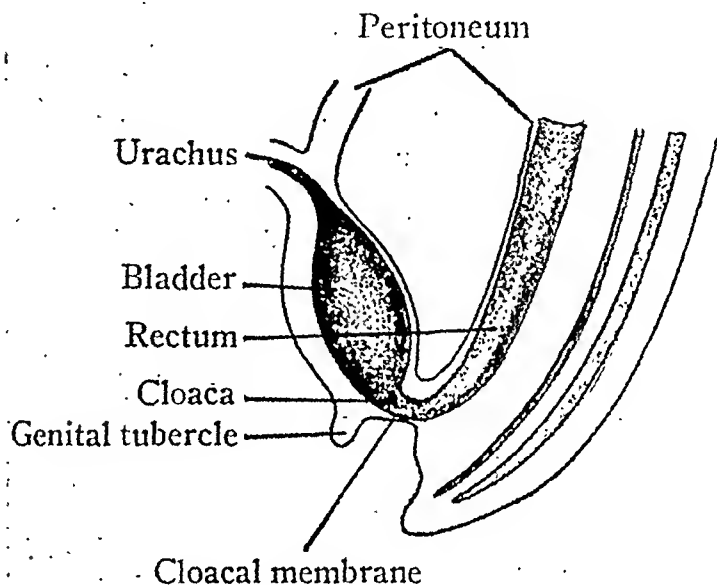


FIG. 1.—Shows the embryological formation of the cloaca and cloacal duct. (After Tieda. Yeomans in Cooke, Diseases of the Rectum and Anus. Courtesy F. A. Davis Co.)

1.) The ventral portion develops into the bladder, prostate, membranous urethra and urogenital sinus. The dorsal portion forms the rectum.

*Theories.*—First. Invagination of the ectoblast at the site does not take place. Second. Rudimentary invagination, but anus remains imperforate and anal membrane persists in whole or part. Third. Post allantoic gut undeveloped, does not ascend and ends blindly. Fourth. Post allantoic gut descends but grows backward and remains out of alignment with the proctodeum and the intervening tissue not absorbed. Fifth. Growth of cloacal partition is arrested and communication is made between rectum and parts in front of it.

Imperforate anus is not a common occurrence, many large hospitals not having a record of a single case. This case we are presenting is very rare, as there is a true cloacal duct and no external communication with the surface. During the process of development, arrestment may occur at any point below the promontory of the sacrum. This being the case there may be a communication with the 1, vagina; 2, urinary bladder; 3, urethral outlet; 4, spinal outlet; 5, uterus; 6, ureters; 7, vulval outlet; 8, perineum, scrotum, anterior urethra; 9, prepuce. The developmental defect communicating between the

rectum and urinary bladder is very rare. Yeomans<sup>14</sup> collected forty-five cases of Imperforate Anus, and did not find a single case presenting this anomaly. Fetchet<sup>5</sup> collected thirty-one cases occurring between 1873 and 1926 and reported one such case as the one we are reporting. Others who have reported cases are Bordenhauer,<sup>3</sup> Anders,<sup>14</sup> Curling,<sup>14</sup> Hayes,<sup>6</sup> Cripps,<sup>4</sup> Tuttle,<sup>11</sup> and Helwig.<sup>7</sup>

*Occurrence.*—Imperforate anus occurs in a different ratio according to different writers, some estimate once in twenty-five thousand births, Starr estimates its occurrence once in ten thousand births.

*Sex Incidence.*—In an analysis of thirty-three cases by Fetchet<sup>5</sup> there were thirteen females, or thirty-nine per cent. Twenty males, or sixty-one per cent., showing that it is more common in males than females.

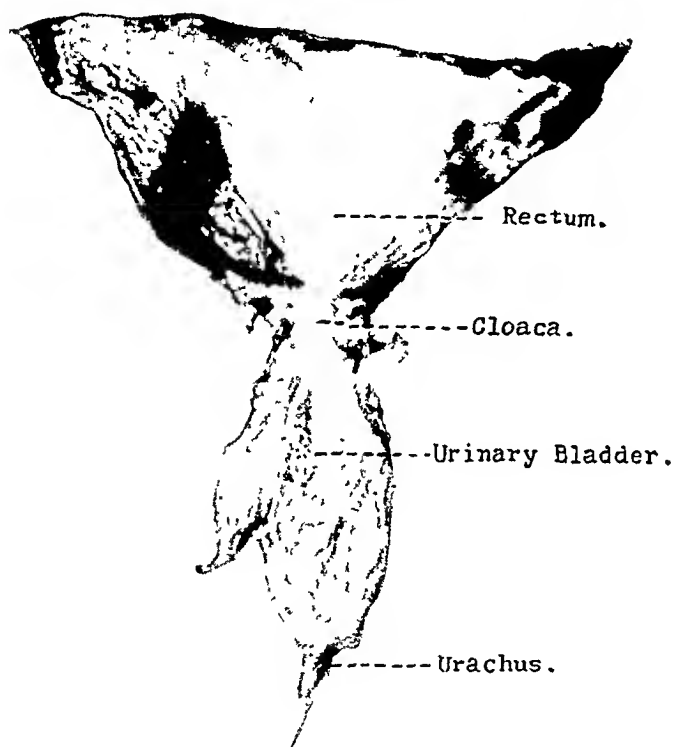


FIG. 2.—Showing gross specimen with persistent cloacal duct, which communicates the distal colon with urinary bladder.

The prognosis depends a great deal upon the type of anomaly and its communication, also any other type of anomalies present. If the imperforate anus does not have communication with some other viscus or with the skin surface, symptoms of obstruction are present at once. Morgagni reported a case of a female with a communication between rectum and vulval outlet who lived to be a hundred years, bore and reared a family of several children and was not aware of her anomaly.

The causes of death are distention of the bowel with gas and intestinal paralysis, vomiting with dehydration, acidosis and peritonitis. The surgeon may do a colostomy or ileostomy, but if intestinal paralysis is present the relief is nil.

*Treatment.*—If there is a fistulous communication with the skin surface in the perineum, this should be dissected out and establish its communication with the surface. If there is no external fistula, and about forty per cent. have an external fistulous opening, one should explore the perineum first to see if he can palpate any pulsation of the bowel, and if he can, then the bowel can be delivered and temporary drainage instituted. If no bowel is encountered the surgeon should not waste any time exploring, but should go above in

## IMPERFORATE ANUS WITH CLOACAL DUCT

the left mid-line and do a colostomy or ileostomy. One must always remember that this is an emergency procedure and no time should be wasted, as the child is only a few hours or few days old, and a bad risk to start with, and it is of the greatest importance to save time.

CASE REPORT.—Father thirty-four, living and well. Mother thirty, in good health. One child, three, in good health. No congenital anomalies in the family. (Dr. A. A. Fricke.)

This infant was of normal pregnancy, normal term, and normal delivery. There was no complication at any time during the pregnancy. Birth of the child was on August 5, 1929. Weight, 7 pounds and 8 ounces, male. After delivery on physical inspection there was visible a small fold of dark pigmented skin in the mid-line of the perineum, also an increase in the size of the scrotum. There was no external rectal or fistulous opening. No other external anomalies were present. The presence of an Imperforate Anus was evident. The infant was taken to the operating room several hours later. After infiltration of the skin in the mid-line of the perineum with one-fourth per cent. novocain, a mid-line skin incision with blunt dissection was done. After blunt dissection no bowel could be palpated, and no pulsation of the bowel was seen when the child cried, as often is the case in this type of anomaly. A rather firm ridge could be palpated which was reported to be a persistent fibrous urogenital fold. Under one-fourth per cent. novocain a left rectus incision was made and a colostomy was done. This colostomy drained very little and the child retained very little nourishment, and died after four days.

Autopsy made by V. L. Andrews, pathologist Hollywood Hospital, showed the distal sigmoid colon to be dilated and through a hard fibrous duct to communicate with the urinary bladder. (Fig. 2.) There is no fecal material in the urinary bladder. The seminal vesicles, and vas deferens are apparently normal. The ureters enter the urinary bladder in the relative normal position. There are no ulcerations or hæmorrhages in the bowel.

The reason for presenting this case is that it is very rare, and presents a true cloacal duct with communications between the distal sigmoid and urinary bladder. Also there was no fistulous opening communicating with the surface, a condition that exists in about forty per cent. of the cases. The surgical treatment in this type of case has very little to offer. The cases occurring with imperforate anus and absence of the rectum have a mortality of approximately 100 per cent.

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## BOOK REVIEWS

ORTHOPEDIC SURGERY. By Sir ROBERT JONES and ROBERT W. LOVETT, M.D. Second Edition revised, with the collaboration of Nathaniel Alison and Frank R. Ober, M.D., and Harry Platt, M.D. William W. Wood & Co., 1929.

The second edition of this valuable text-book appears after the death of its distinguished American co-author. The collaborators from both sides of the water have seen to it that the new edition is thoroughly modern in its presentation of the developments in orthopedic surgery since the first edition was issued.

In a very brief discussion of the work as a whole, several thoughts come to mind. In this volume are amalgamated the theory and practice of two great schools of this somewhat ill-defined but ever-growing specialty. These two schools agree very largely in viewpoint and enthusiasm. Yet it is relatively easy to discover, in perusing its pages, wherein they vary in practical applications. And therein perhaps lies the peculiar value of the work.

The sections dealing with what may be termed "pure" orthopedics are adequately represented and well elaborated, with perhaps one single exception, and that is in the discussion of coxa vara. Since in the presentation of coxa vara comparatively little emphasis is placed upon the commoner clinical types, the treatment outlined is correspondingly vague and not entirely satisfactory.

The sections dealing with disabilities of the knee-joint and with cerebral palsies of childhood deserve careful reading as the expression of pioneer work done by the authors. The sections dealing with fractures merge with the field of the general surgeon, but emphasis is placed upon those fractures in which the orthopedic surgeon is commonly consulted, that is fractures involving joints.

The work is to be highly recommended to all students and practitioners interested in the pathology and treatment of injuries and disorders of the locomotor apparatus.

ARTHUR KRIDE.

SURGICAL PATHOLOGY. By WILLIAM BOYD, M.D. 2nd edition, 8vo. cloth; 898 pages. Phila., W. B. Saunders Co., 1929.

The opening sentence in Boyd's book is "The Surgery of today is based on pathology." This author goes on to divide the history of surgery into two periods—before John Hunter and after, in effect that before Hunter it was content to be an art founded on empiricism and after him it aspired to be a science founded on pathology.

The second chapter is devoted to "The Surgeon and the Laboratory." In this are considered the surgical infections, vaccines, sera, methods of collection of material, cytologic examination of the fluids obtained from the end results of malignant involvement, leucocytosis and blood transfusion.

The comment on this chapter applies equally to the one following (Inflammation and Repair), namely: the thoroughness with which the subjects are dealt merits commendation.

From special chapters devoted to tubercular, mycotic and luetic surgical affections as well as thrombosis and embolism, the author digresses a little to consider surgical shock and the etiology of tumors and heredity in cancer. While strictly speaking these are not subjects of surgical pathology, the material is so well handled, that it becomes a pleasant digression to the reader.

Only moderate space is devoted to the benign tumors, but the more malignant (especially carcinoma) are considered at length and are taken up in correct detail with the individual organs.

The surgeon must not only see but he must understand what has gone before and what is most apt to follow and the student of Boyd's Surgical Pathology will forgive the author his interspersions of physiology, physical diagnosis and prognosis. For the lack of these is the great fault of some other works.

Especially luminous are the chapters on the stomach, peritonitis and surgical affections of the genito-urinary tract. The vividness and clarity with which these subjects are described is worthy of any comprehensive work on physical diagnosis and certainly leaves little undescribed as to what the surgeon may encounter, and encountering, judge the outcome.

One might take exception to the inclusion of such a subject as status lymphaticus, but as the author observes, many cases of death under anæsthesia are due to this cause.

The student will find the chapters on bone and joint pathology especially useful in differential diagnosis and a definite aid in the choice of treatment to be instituted.

It is a satisfaction to note that Boyd believes in syphilis of bone as a distinct pathological entity, and that rickets, osteo-malacia and osteitis deformans are states with which the surgeon must be familiar. Frequently their existence may prove a potent factor in medico-legal practice and worse still in unfavorable outcome.

The reviewer feels that the subject of tumors of the bone is not as amply treated as one would expect after perusing the subject of osteomyelitis, but the primary tumors are well described and one must agree with him that the bewildering variety of names encountered in the literature regarding this subject are of doubtful value, and quite confusing. The four main types of primary tumors are stated to be osteogenic sarcoma, Ewing's tumor, myeloma and giant-cell tumor. The recognition of these types practically covers the field of surgical pathology of bones.

In conclusion a surgical pathology like a surgical anatomy, is difficult to comprehend without clinical embellishment and for his ability to so embellish his work, this author is to be highly commended.

BARNET JOSEPH.

MINOR SURGERY, by FREDERICK CHRISTOPHER, M.D. Large octavo; cloth; pp. 694. Philadelphia, W. B. Saunders Co., 1929.

The remarks anent the subject of Minor Surgery, in reviewing, in the September ANNALS, the book of Foote and Livingston, are equally applicable, *mutatis mutandis*, to this book of Christopher, the chief change being that the one book comes from the city of New York and the other from the city of Chicago.

Here is a book of 694 octavo pages with 465 illustrations, many of which, though diagrammatic, illustrate well important points. There is one peculiarity about the book which cannot fail to arrest attention, that is the inclusion of certain fractures which the author says "may properly be included in the domain of Minor Surgery." "The care of others, however," he says, "is distinctly a major surgical procedure and will require all the skill and ingenuity possible." Naturally the question of what injuries should be included and what excluded may be subjects of difference of opinion. One point, however, in this connection the reviewer observes with regret, namely, that the author refers to plaster bandages used in the treatment of certain fractures, as plaster casts! Will the surgical profession ever free itself from that egregiously, erroneous use of language?

Under the heading of Minor Surgical Technique, there are only three pages devoted to local anæsthesia—all that the author has to say upon the subject. When one considers, however, the very great importance and increasing extent of the application of local anæsthesia in surgical work, one cannot help but feel that more detailed attention should be given to this subject in a work on Minor Surgery. The subject of Bandaging also, which certainly covers a very large field in Minor Surgery, receives very scant attention, only a half dozen pages being devoted to this subject.

The book as a whole, however, reflects well the character of the surgical practice of today. The dictum of the author in his preface that "there cannot be too much instruction in minor surgery" is well founded. The tendency of the present day is for every neophyte to rush into major surgery. The present book should help to stem that tendency.

THE PREPARATION OF CATGUT FOR SURGICAL USE. By W. BULLOCH, L. H. LAMPITT, and J. H. BUSHILL. Octavo, paper; pp. 186. London, His Majesty's Stationery Office, 1929. New York: British Library of Information, 5 East 45th Street.

A report from the Medical Research Council of the Privy Council; a series of studies made on behalf of the London Hospital Catgut Department.

Next to freedom from bacterial contamination in operative work, the use of an absorbable ligature is the most essential element of modern surgery. The use of non-absorbable materials for ligature purposes, such as silk or silver clips, is so restricted in its application as to be practically ignored in general use, although their mention may not be omitted in connection with certain classes of surgical work or the work of certain surgeons. Catgut, as



the absorbable ligature *par excellence*, is therefore of very great importance in modern surgery and every fact bearing upon its sterility and tensile strength is of deep interest. Lister labored for over forty years to improve the modes of its preparation. The present work by Professor Bulloch and his collaborators will stand in historical succession to the classical studies of Lister. It is of interest to note that in addition to the contributions to the bacteriology and physical chemistry of surgical catgut which the book makes, it contains a most complete account of the history and literature of the whole subject.

The importance of such a series of studies is well illustrated by the fact, as reported by the committee, that of eight batches of catgut ligatures, made by different English and American makers, purchased in July, 1927, some infection was found in every batch, and in five of the batches, not more than one ligature out of the ten was found to be free from infection. Of one particular batch, thirty-six ligatures were tested and every one of them proved to be infected, although the maker had claimed that all were sterile. For good reason, therefore, the licensing authority of Great Britain, under the Therapeutic Substance Act, has added surgical catgut to the list of substances to be controlled by it, so that in Great Britain at least the catgut supplied for surgical operations will have a sufficient guarantee as to the purity and quality claimed for it. Would that some similar authority could be given the supervision of the catgut supplied for surgeons' use in the United States of America, such an official guarantee should be welcomed by the great purveyors of catgut ligatures upon whom surgeons have come to depend so largely for trustworthy ligature material.

A distinction must be made, however, between practical clinical sterility and laboratory sterility. In the laboratory, the tests to which the catgut must be subjected are elaborate and minute. One is interested to read that the reporter has made not less than thirty thousand bacteriological tests of catgut ligatures. Surely such an experience must qualify him to speak as an authority. He says that the proof of sterility should be made only after complete removal of any disinfectant if such has been used for the purpose of sterilization; second, the cultures should be made in such a way that both anærobes and ærobes can grow in the medium employed; third, the nature of the bacteria cultivated should be examined with object of finding whether they are part of the intestine flora or merely an ærial contamination; fourth, the pathogenic action of the whole mixed culture obtained or particular bacteria isolated pure from the mixed culture should be investigated; fifth, inoculation of filtrates from catgut cultures may be necessary to reveal the presence of some bacterial toxin such as tetanus; sixth, the quantity of catgut employed for the test is not a matter of indifference. Since in practical use a length of from twelve to fifteen inches is used by a surgeon, such a length should therefore be the quantity used for the tests. Such is the character of the test for sterility to which the authors have subjected the catgut examined by them and which is the subject of this report. It is not to be

forgotten, however, that in the clinic catgut is subjected to quite a different kind of test. The catgut is not subjected to the removal of the disinfectant which has been removed for its sterilization. On the contrary, such disinfectant is always present and, as all surgeons know, whether the catgut is absolutely sterile or not from the laboratory standpoint, from the clinical standpoint it may be innocuous, due to the inhibiting action of the disinfectant present in its meshes. This is recognized by the experimenters in their statement that whatever penetration of an antiseptic has taken place in the substance of the catgut, its inhibiting action may give deceptive results, for the catgut may be washed for a very long time in many changes of sterile distilled water and still enough of the antiseptic may adhere to the catgut to inhibit the growth of any contained bacteria even if transferred to a highly nutritive medium. No doubt, therefore, a good deal of the catgut used is not dangerous even if it contains bacteria. But where harmless bacteria are found, there may be harmful bacteria also, and if all bacteria can be excluded, they should be. Although a great deal of so-called sterile catgut is not sterile, one must assume that the bacteria present are relatively innocuous. The comparative rarity of infections which can be traced to infected catgut, notwithstanding the enormous extent of its use and its possible imperfect sterilization, is apparently due to such inhibiting action of the disinfectants used in its preparation and retained in its substance. This penetration of chemical substances into catgut was also subjected to study. The general statement is made that owing to the physical or chemical properties of catgut almost all substances experience difficulty in effecting an entry into the fibres. This is the reason why the disinfection of catgut is such a troublesome affair. The experiments of various observers along this line are referred to. Especially significant is the work of Claudius (1906) in drawing attention to the rapid penetration of aqueous iodine solutions into catgut ligatures. Claudius found that aqueous solutions of iodine penetrated to the centre of ligatures very quickly; not so ligatures immersed in alcoholic or acetone solutions of iodine.

The methods of disinfecting catgut are most fully considered and occupy more than half of the space of the whole report. Successively carbolic acid, corrosive sublimate, biniodide of mercury, chromic acid, silver compounds, oil of juniper, oil of turpentine, formaline, hydrogen peroxide, aniline dyes, anhydrous fluids at high temperatures and hot air are passed under examination. These pages form a most interesting section of the report. To one who, like the reviewer, has been familiar with each of the methods considered from the very beginning of Lister's experiments with carbolic acid through all the gamut of change to the present time, it is full of interesting reminiscences. It may suffice, however, here to give the conclusions of the reporters as contained in their summary, namely that the preparation of catgut for surgical use on a large scale resolves itself into chemical sterilization by iodine or peroxide of hydrogen or the physical sterilization by heat. In the experiments given it is stated to be of importance to remove the iodine from the ligature after it has completed its sterilizing action because of its weakening effect on

its tensile strength and the practical recommendation is made that seventy per cent. alcohol should be used for the storage of ligatures since it also serves to remove the excess iodine. It is recommended also that to this iodine there be added a small amount of glycerol, five to ten per cent., the glycerol rendering the texture of the catgut soft and flexible and more suitable for surgical use. Appended to the report is an extensive list of references. The whole report is one of great interest and importance dealing as it does with practical questions that interest every surgeon.

LEWIS S. PILCHER.

#### EDITORIAL ADDRESS

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## TREATMENT OF ANEURYSMS OF THE THORACIC AORTA AND INNOMINATE ARTERY BY DISTAL ARTERIO-VENOUS ANASTOMOSIS\*

OBSERVATIONS ON TEN CASES WITH OPERATIONS IN EIGHT CASES

By PATRICK A. MCCARTHY, M.D.

OF PHILADELPHIA, PENNA.

ANEURYSM of the thoracic aorta has been known to the profession as an entity since the time of Vesalius. Volumes of literature have been written on the subject, much of it by the French and Germans. Lately most of the writing and work on this subject has been done by English and American physicians.

From the earliest recognition of this condition, syphilis has been presented as the primary causative factor, but within the last half century much work has been done to show that there may be other agents that may induce aneurysm not only of the aorta, thoracic and abdominal, but of other vessels as well.

Lancisi<sup>1</sup> was convinced of the common association of syphilis and aneurysm. Ambroise Pare<sup>2</sup> (1510-1590) was the first to describe syphilis as the cause of aneurysm, but the existence of aneurysm was known before this time. Aretæus,<sup>3</sup> the Cappadocian, sometimes called the forgotten physician who lived between the fourth and seventh century, definitely and clearly described aortitis. He also described angina, sometimes associating the two and thus presenting possibly the earliest known recognition of aortic aneurysm.

The first clinical description of aneurysms of the aorta, both thoracic and abdominal, according to Roth, was given in 1511 by Andreas Vesalius,<sup>4</sup> the Father of Anatomy; although various authors have credited Galen with the description of pulsating masses, and arterio-venous aneurysms.

The first mention of abnormal aortic pulsation was made by Hippocrates<sup>5</sup> in his observations on neurotic individuals. Some of these cases may have been aneurysm, but Morgagni first described these abnormal pulsations as due to dynamic dilatation in neurotic conditions. The observation of preternatural pulsation leading to the diagnosis of aneurysm really originated with Morgagni.

Harvey (1578-1657) in Chapter III of his *De Motu Cordis* first noted changes in the pulse in thoracic and cervical aneurysms and describes it as follows:

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\* Read before the Philadelphia Academy of Surgery, October 7, 1929.

"A certain person was affected with a large pulsating tumor on the right side of the neck, called an aneurysm, just at that part where the artery descends into the axilla, produced by an erosion of the artery itself and daily increasing in size, this tumor was visibly distended as it received the charge of blood brought to it by the artery with each stroke of the heart; the connection of parts was obvious when the body of the patient came to be opened after his death. The pulse in the corresponding arm was small in consequence of the greater portion of the blood being diverted into the tumor and so intercepted."

From the time of Harvey's imperishable work until the time of the Hunters, William and John, there seems to have been nothing further done in this field, even though the association of disease and the clinical and post-mortem findings were well established.

The advent of the Hunters and Valsalva marks the first definite steps

taken toward the treatment of aneurysm. Previous to this time, the recognition was apparently sufficient. Valsalva<sup>6</sup> advocated treatment consisting of three things: rest, low diet, now known as liquid or starvation diet, and bleeding. This course was followed assiduously by Albutini and other Italian physicians of his time in the eighteenth century, but was violently decried by Morgagni, who maintained that Valsalva frequently killed his patients by exsanguination. It is interesting to note at this time that one of the reigning sovereigns of England, King George II, died suddenly of what subsequently proved to be a ruptured dissecting aneurysm



FIG 1 —Case I. Röntgenogram taken after operation.

of the right heart (*i.e.*, the ventricle). In 1736 Petit<sup>7</sup> reported a case of thoracic aneurysm in the History of the Royal Academy of Science in Paris. William Hunter<sup>8</sup> in 1757 reported a case of perforating aneurysm of the aorta which he quaintly describes as "weeping a great lot and having in its centre a small plug that did blow out during a spell of coughing." At about this time, William White, a surgeon of York, reported to William Hunter his observations upon listening over an aneurysm. This observation was made over a varicose aneurysm, but is probably the first authentic report of auscultatory findings from an aneurysm. Brasdor<sup>9</sup> in 1760 first suggested distal ligation of the main trunk beyond the aneurysm. While aneurysm of the aorta was inoperable up to this time, aneurysms of the extremities were operated upon. Percival Pott had advocated amputation of the extremity above the aneurysm and until the time of John Hunter's memorable experiment, all these individuals died. Those who did not submit to operation apparently had a better chance than those who did, as Garrison states that the operation of Pott was always fatal.

John Hunter<sup>10</sup> (1728-1793) did a ligation of the external carotid artery on a buck deer in Richmond Park to see what effect it would have. He noted that the antler on the side that had been tied off, became cold to the touch, but a week or two later, he was surprised to find that it was warm again. To satisfy his curiosity, Hunter killed the deer to determine the reason for this phenomenon and thereby established the fact that anastomotic vessels would enlarge to care for parts supplied by destroyed vessels. Satisfied as to the value of the collateral circulation, Hunter determined with his indomitable courage to attempt ligation of the femoral artery on a patient with a large popliteal aneurysm.

The artery was ligated in what is now known anatonically as "Hunter's Canal", and the patient not only lived but walked out of the hospital cured,



FIG. 2.—Case II. Röntgenogram taken before operation.



FIG. 3.—Case II. Röntgenogram, after operation. Noted decrease in height, thickness and size. Also angulation now present. Heart small in size.

the first successful proximal ligation of a great vessel for the relief of aneurysm on record. After this advance, no further steps of importance are recorded until the nineteenth century, when several valuable contributions were made.

Joseph Hodgson<sup>11</sup> in 1815 first distinguished between the dilatation of aortitis and aneurysm, both of which were impossible of differentiation from the time of Aretæus and sad to relate are still unrecognized in many cases today. Shekelton,<sup>12</sup> a Dublin surgeon, in 1822, reported the first case of healed aneurysm, that is, of so-called spontaneous cure. Wardrop<sup>13</sup> in 1827 ligated the subclavian artery for cure of aneurysm of the innominate artery, the circulation being partly arrested in this procedure. John Thurman<sup>14</sup> in 1840 made the first report on aneurysm of the aorta communicating with the superior Vena Cava. Observations along this line of endeavor were increasing. Recognition of various types of aneurysm was being made; the subject was becoming clearer. Liston,<sup>15</sup> a famous London surgeon of his time, in

July, 1847, had a profuse hæmoptysis due to an aortic aneurysm and recognized this as the underlying cause. He nearly died as a result of this, but rallied sufficiently to live six months longer. He then died in a severe paroxysm of dyspnœa.

Charcot<sup>16</sup> presented the first recorded case of intermittent claudication in relation to aneurysm of the internal iliac artery. Corrigan,<sup>17</sup> the famous Irish portrayer of the water hammer pulse of aortic insufficiency, was the first to definitely differentiate between aneurysm of the aorta and aortic insufficiency. He cites a case: "So strong were the pulsations for years in the region of the arterio-innominate that until the examination after death, there was never a doubt expressed that the case was not aneurysm". Many of the famous clinicians of this time were failing on this point and many were unconvinced in spite of Corrigan's work.

Broadbent<sup>18</sup> made the first real attempt to classify internal aneurysms

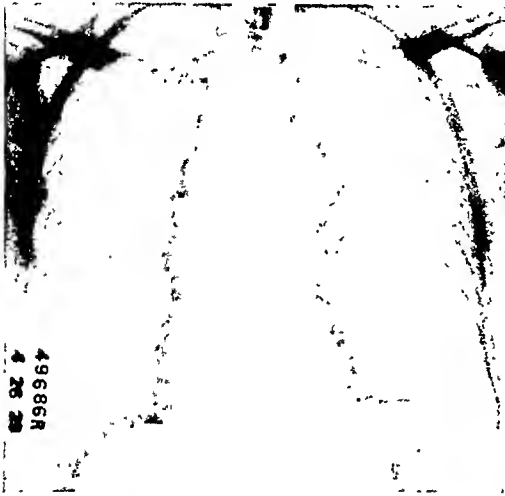


FIG. 4.—Case III. Röntgenogram, taken before operation.



FIG. 5.—Case III. Röntgenogram, after operation. Apparently no change.

clinically, dividing them into the aneurysms of signs and the aneurysms of symptoms, although in this series of cases not one could be distinctly placed as belonging to either class. In 1864, C. H. Moore<sup>19</sup> made apparently the first attempt to wire an aneurysm. He introduced seventy-eight feet of wire into the sac with no apparent relief, the patient dying five days later. Parham,<sup>20</sup> in 1895, reported an unsuccessful attempt at ligation of the innominate artery for aneurysm. Gay,<sup>21</sup> in 1897, reported a case of successful ligation of the innominate with apparent cure. Noble,<sup>22</sup> in 1898, tried the introduction of gold wire into an aneurysmal sac and the passing of a galvanic current in an attempt to induce thrombosis.

During the latter part of the nineteenth and up to the present day of the twentieth century, many attempts have been made and much has been accomplished to cure or relieve this painful and fatal affliction. Many causes, other than syphilis, trauma, hard work, etc., have been determined.

Dickinson,<sup>23</sup> of London, in 1902, advanced hypoplasia of the aorta as a

cause of aneurysm. Ribbert,<sup>24</sup> of Westphal, in 1910, suggested tuberculosis as a causative factor. Oudler,<sup>25</sup> of Montpellier, in 1912, determined on a rheumatic origin. Neuber,<sup>26</sup> of Berlin, in 1913, volunteered mycotic infection as a cause and Morgan and Teacher in the British Medical Journal of 1914 apparently demonstrated bacterial infection as an etiological factor.

Many cases of spontaneous cure are on record. Perrin,<sup>27</sup> of Paris, in 1903, reports one case, while French,<sup>28</sup>, Pratt,<sup>28</sup> and Surgeon Major Oliver,<sup>28</sup> the expounder of the Tracheal Tug, known sometimes as Oliver's sign, in 1909, reported a case of spontaneous cure.

O. K. Williamson,<sup>29</sup> in 1907, remarked on the arterial blood pressure in aneurysm as being normal or slightly above normal. In most cases of thoracic aneurysm, there is a marked difference in blood pressure in the arms. A difference of 20 millimetres Hg (Mercury) or more suggests the diagnosis of aneurysm. Moore and Corradi<sup>30</sup> used their method of wiring



FIG. 6.—Case IV. Röntgenogram, before operation.

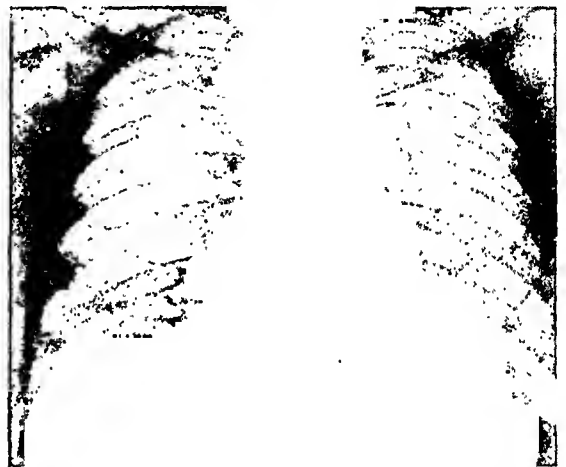


FIG. 7.—Case IV. Röntgenogram taken after operation. There is a decrease in height of the sac and width of the auricles.

in twenty-three cases of aortic aneurysm, seventeen of which were thoracic; in eight of the twenty-three cases, there were amelioration of symptoms and probable prolongation of life. Colt's<sup>31</sup> modification of the "wiring method" by introducing galvanism resulted in some cures. Hare has wired thirty-eight cases by this method. Reid,<sup>32</sup> in a summary of an excellent article on aneurysms, reported forty cases which were wired—thirty-eight of the aorta (arch descending and abdominal), one of the innominate artery and one of the superior mesenteric artery. No cures and possibly relief in five cases. Macewen,<sup>33</sup> of Glasgow, introduced the method of needling the interior of the sac to promote thrombus formation. William Murray,<sup>34</sup> of New Castle-on-Tyne, reported one case of abdominal aneurysm cured by digital compression. Rosenstern,<sup>35</sup> of San Francisco, operated upon a perforating sac. The patient lived many years. Halsted<sup>36</sup> attempted to relieve dyspnoea due to pressure by resecting the upper portion of the sternum. He then placed one of his bands around the aorta above the sac. This patient died on the table in a paroxysm. Da Costa,<sup>37</sup> in 1910, operated on two cases of innomi-



nate aneurysm doing double distal ligation at one seance. One case was living five years after operation and was then lost track of. The other died one and one-half years after operation, due to rupture of a secondary aneurysm of the carotid artery at the point of ligation.

There have been according to Osler<sup>38</sup> twelve ligations of the abdominal aorta, for aneurysm, all of which were fatal.

The next radical attempt at relief of intrathoracic aneurysm was made by Babcock,<sup>39</sup> in 1925, by anastomosing the common carotid artery with the internal jugular vein, with very gratifying results. His case lead to the operations in this series of cases being performed in the same manner.

With such chaos existing in the treatment of aortic aneurysm, Dr. W. Wayne Babcock, Professor of Surgery, Temple University, devised and executed an operative procedure which may revolutionize the treatment of



FIG. 8.—Case V. Röntgenogram, before rupture. FIG. 9.—Case V. Röntgenogram, after rupture.

these cases. The principle of his operation is reduction of intra-vascular tension, by increasing the velocity of the blood through the sac. All other operations depend upon slowing or abolishing the flow of blood through the aneurysm.

The case selected by Doctor Babcock was a large saccular aneurysm of the aorta on the right side perforating the chest wall. The patient suffered severe thoracic pain. The operation was performed September 21, 1925. The distal ends of the common carotid artery and the internal jugular vein were ligated and the proximal ends were anastomosed end to end.

For two or three days, following operation, the patient was in a serious condition from pulmonary congestion, then a marked fall in blood pressure occurred, with great improvement and relief from pain. There were no cerebral phenomena and the venous circulation in right side of the head and neck was improved. The patient was able to return to his occupation as an automobile mechanic. Doctor Babcock reported his case five months after operation; the patient had some return of pain with increased blood pressure, but this did not prevent his doing active work.

That the operation carries with it decided elements of danger in its performance must be admitted, but we must also remember that this type of aneurysm is inevitably fatal.

All methods of surgical intervention in the treatment of aneurysm have certain disadvantages. Distal ligation, according to Jacobsthal,<sup>40</sup> presents great mortality with little or no subsequent advantage. Collaterals enlarge, new sacs may form, cerebral complications often result and in 120 cases of combined aortic and innominate aneurysm reported by him, as treated by distal ligation, only two lived more than three years. Needling, the injection of coagulations into the sac and other procedures, with the exception of wiring, have all been discarded. Wiring of aneurysms has been extensively used, but it is obvious that it can be applied only to easily accessible saccular



FIG. 10.—Case V. Autopsy specimen.

aneurysms. There is no defined path of insertion of the wire and only too often has this method resulted in the wire afterwards being found coiled outside of aneurysmal sac; in the lumen of the artery or the heart cavity, even resting in the mediastinum. Wiring, of course, never leads to the formation of a firm clot. Time alone will tell whether or not the Babcock procedure is indicated in place of wiring, but it is evident that this anastomosis can be used for any type of aortic or innominate or combined aneurysm. Furthermore, a foreign body is not introduced into the pathway of the moving blood stream with its subsequent danger, as in wiring. It will be seen from the technic that the anastomosis is performed in an exposed field with facility of access and ease of control, whereas wiring must be done more or less blindly. The operation of anastomosis is founded upon sound surgical and physical principles. In order to explain the physics, one must call upon elementary hydro-dynamic laws, governing the action of moving fluids and from them arrive at a logical conclusion.

It is accepted that: 1. Moving fluids have resistance. (a) from the cohesion of molecules to each other. (b) from the adhesion of molecules to the sides of the conducting vessels.

2. Moving fluids have velocity, the velocity depending upon the force driving the fluid and varying inversely to the lumen of the conducting vessel.

3. All fluids, whether in motion or at rest, have volume. This volume remains constant because of the fact that fluids are incompressible. A further factor in the resistance of fluids may be considered as the total volume of all the fluid ahead of a certain point. This volume in itself, through its weight and the force required to move it, may also be considered as exerting backward pressure known as head pressure. When this head pressure is measured by means of volume in a container of known height and lumen, it is known as pressure height.

These elementary laws in relation to moving fluids may be applied to the circulation of the body, the blood being considered as the moving fluid.

The head pressure which includes resistance is made up of the following: First: The amount of blood in the arterial and venous systems. Second: The arterial blood pressure which is the pressure exerted upon the blood, by the recoil of the arterial walls.

In relation to velocity, it is stated that the area of all the capillaries is about 600 times greater than the area of the aorta. The velocity of the blood in the aorta is known to be about 300 millimetres per second; the velocity of the blood in the capillaries must be 600 times slower than in the aorta, therefore, the capillary velocity is one-half a millimetre per second. Conversely, the blood as it loses velocity in the arterial system, must gain velocity in its course from the venous capillaries, toward the vena cava. The vena cava in itself is less in diameter than the aorta; but we must consider there are two, superior and inferior, vena cava emptying into right auricle. Providing the driving force always remains the same in a closed system and we can consider the circulation of the blood as a closed system, the blood must enter one chamber of the heart as fast as it leaves the other. Toward the capillaries, the combined lumen becomes larger; thereby decreasing the resistance; the volume always remains the same, since fluids are not compressible, therefore, the velocity must decrease and if this is so, the converse must be true.

The pressure from the heart, which is estimated by physiologists as about 3 pounds, is exerted upon the vessel walls and gradually decreases in the smaller arteries toward the capillaries, where it falls so low that when the capillary bed is passed, the velocity is increasing and becoming more marked as the veins enlarge. It can be seen that the veins in themselves exert a sucking or aspirating effect, greater in intensity toward the heart, at which point the maximum aspiring effect is reached. By way of explanation, it is stated that a column of mercury one hundred and fifty millimetres high, with a diameter of one millimetre, is equivalent to two and one-tenth grams of weight. The area of the aorta is stated at about 615 square millimetres.

Using these figures as a means of conversion, a measurement may be reached of 3 pounds weight or pressure, exerted upon the valves of the aorta by the total volume of blood in the arterial system ahead of the valves. Now, if this weight of 3 pounds is exerted upon the valves, it must be also exerted upon the walls of the aorta, the force exerted upon the walls being known as radial or lateral pressure. If this be so, and the arterial walls contract or re-coil to drive the blood further, they must also exert a slightly greater force than this in order to help the blood forward. It is known that the pressure in the ventricles of the heart is about 150 millimetres of mercury and that only one-half millimetre of mercury is necessary to propel the blood from the heart. Therefore, one hundred forty-nine and five-tenth millimetres are utilized in overcoming head pressure.

This head pressure, which was explained previously, may be increased. First: By an increase in the frequency of the heart beat. Secondly: By an increase of the force of the heart beat. Thirdly: By an increase in peripheral resistance.

This being true, the converse must be true. That is, that a decrease in peripheral resistance decreases head pressure.

As head pressure is decreased, so is the necessity of force required decreased and as a result there is less force required by the arterial walls to propel blood forward. A removal of force therefore entails removal of lateral pressure on the arterial wall, and less effort for the heart.

From the foregoing statements, two facts present themselves predominantly: First: The intra-ventricular and arterial pressure is positive. Secondly: The venous pressure is negative.

Applying these facts to an anastomosis of the common carotid artery with the internal jugular vein, one will see that there is little or no strain exerted upon the point of anastomosis. When the blood supply of one-half the head is cut off above a certain point, the head pressure, which includes the resistance caused by all vessels ahead of this point, is removed. Therefore, removal of this resistance entails First: Removal of some of the lateral or radial pressure on the artery from the point of anastomosis back to the ventricle. Added to the removal of this resistance there is a corresponding aspirating effect upon this point, exerted by the venous suction. Removal of this head pressure correspondingly affects the velocity and as the velocity is affected so is the driving force, namely, the heart.

An analogy can be shown by the ordinary garden hose. If a garden hose is attached to a spigot and the nozzle shut tightly, so that no water can escape, the hose will soon become quite tense, the tenseness being due to the inability of the water to force itself past complete resistance. If, at any point along this hose, it is severed, the walls of the proximal portion will immediately lose their tenseness and partly collapse, due to the removal of resistance and it will be seen that the water rolls out slowly, at approximately the same or less velocity than with which it leaves the spigot and that there is no pressure exerted upon the opening. In the operation of arterio-venous

anastomosis the head pressure is removed. The blood is incompressible. It goes from a positive pressure of about two and eight-tenths pounds to a negative pressure, and the result should be one of the following:

The heart will "run wild", just as an engine, with its load removed, "runs wild". But if removal of this load (or resistance) and the change from one extreme to the other is accomplished gradually by means of a governor, the engine should accommodate itself just as the heart will, if the shutting off and release of circulation is accomplished gradually. Under these circumstances, as the resistance varies gradually from absolutely positive to negative, so the heart will adjust itself by lowering or increasing its rate.

Sudden removal and sudden release might result in marked arrhythmia. The danger of dilatation of the right heart need not be considered, inasmuch as the volume is not increased and the velocity with which the blood is thrown



FIG. 11.—Case VI Röntgenogram, before operation. Almost same involvement as Case I.

from artery to vein is practically lost before the chamber of the heart is reached. The hazard of mixing of the arterial and venous blood may be ignored, as is proved by the existence, without deleterious effects, of a patulous foramen ovale, and foetal circulation. Apparently, therefore, if the removal of head pressure and a change of pressure from positive to negative is made gradually, there should be no sudden disarrangement of control, but the heart, being readily adaptable, should under the condition, accelerate its rate accordingly. Since the removal of head pressure for one-half the head is entailed in this operation there should be a temporary and slight disarrangement of the whole circulation.

The pulmonary circulation could hardly be affected seriously, inasmuch as the right side of the heart is not affected. The abdominal blood supply is affected in accordance with the changes that occur on the arterial side and may manifest itself by temporary disturbances of the renal and digestive systems, until such time as the heart adapts itself.

Ten cases of aneurysm of the aorta or aortic aneurysm combined with aneurysm of the innominate, were studied in sequence as they were admitted to the hospital, regardless of type or extent of involvement; physical condition was not considered, as each case was a very poor operative risk. All had definite myocarditis; all had nephritis and some had associated hypertension. In brief, these cases were ideal for this series.

Eight of these cases were operated on. Of the two cases not operated on, one was moribund and died shortly after admission. The other, on the service of Dr. E. Eliason, at Philadelphia General Hospital, refused operation and died. Of the eight operated on, one was from Surgical Service A.

## ANEURYSMS THORACIC AORTA AND INNOMINATE

Professor J. Chalmers Da Costa, Jefferson Medical College Hospital. Case was operated on by Dr. T. A. Shallow. One from the service of the author at St. Mary's Hospital. The remaining six cases were on the service of Dr. Hubley R. Owen, at Philadelphia General Hospital, whose hearty coöperation, deep interest and unfailing courtesy made this series possible.

### CASE REPORTS

CASE I.—A. J., male, white, widower, aged fifty-four years, steam shovel worker. Admitted to St. Mary's Hospital, March 9, 1929, discharged March 30, 1929.

*Present Illness.*—Pain in the chest, neck and right shoulder, for the past three



FIG. 12.—Case VI. Autopsy specimen. Notice huge clot filling the innominate artery.

years. Three months ago he noticed a pulsating mass at the right sterno-clavicular articulation which has gradually become larger. Pain more marked. Blood streaked sputum, dyspnea increased on slightest effort. Subject to occasional attacks of vertigo.

*Previous History.*—Sore on penis at age of nineteen, lasted two weeks. Constant user of alcohol, consuming at least a pint of whiskey daily.

*Physical Examination.*—Well developed and well nourished. Cyanosis of lips. Veins on right side of neck and upper chest distended. Chest: at right sterno-clavicular articulation, there is a bilobed obliquely lying pulsating mass, expansile in character, 7 centimetres in length, 4 centimetres in width. Sternal end of clavicle cannot be felt, there is a prominence at sternal junction of the second rib. Heart: There is a systolic murmur at apex transmitted to left. Aortic and pulmonary sounds are accentuated. Blood Wassermann, plus 1—Kahn, plus 4.

*Röntgenogram and Fluoroscopic Examination.*—Heart of average size and position. There is an aneurysm involving ascending portion of aorta and innominate artery, with

dilatation of the transverse and descending limbs of aorta. There is destruction of inner portion of right clavicle.

Blood pressure in the right arm 132/68, and in the left arm 134/68.

Patient was seen by Professor J. Chalmers Da Costa and shown to his class at Jefferson Hospital, he concurred in the diagnosis and advised the operative procedure.

*Operation* March 19, 1929. Vein was larger than the artery by one-half of its diameter. The artery was thick and sclerotic and after cutting, several small fragments of calcified substance, resembling pieces of egg shell were removed from the intima.

After the tapes were removed and the circulation completely established the vein was seen to fill with blood during systole of the heart. The arterial stream could be felt going over to the vein and a slight impact seen. During diastole the vein was reduced in size as it was emptied of its contents, due to the aspirating effect of the venous system.

Patient reacted well, following operation.

March 20, 1929.—Some reduction in size of aneurysmal sac noted, no pain, no blood streaked sputum. Rapidity of pulse noted on removal of arterial tape, disappeared in twelve hours. Blood pressure in the left arm 146/70 and in the right arm 130/70.

March 22, 1929.—Patient is comfortable. Blood pressure in the right arm 134/86 and in the left arm 138/64.

March 25, 1929.—Wound dressed, stitches removed. There is a decided bruit over anastomosis, no pain. Blood pressure in the right arm 130/90 and in the left arm 132/88.

March 30, 1929.—Discharged from hospital. No pain or cough, aneurysmal sac is more rounded and smaller. Pulse 70 in both wrists. Blood pressure in the right arm 140/90 and in the left arm 138/88. No dyspnoea on exertion.

April 23, 1929.—Blood pressure in the right arm 133/80 and in the left arm 150/70. Condition good.

September 20, 1929.—Patient at present is in good condition—free from pain, dyspnoea, vertigo or cough. He is able to walk long distances without difficulty. Size of aneurysm has increased—it is more rounded in shape—pulsation is not so marked.

CASE II.—J. G., aged forty years, colored, laborer. Admitted to Philadelphia General Hospital, as a case of pulmonary tuberculosis. Complaining of pain in the anterior right side of chest.

*Previous History.*—No history of previous illnesses, but acknowledged chancre of indefinite date.

*Present Illness.*—About two months before admission patient developed a non-productive cough and hoarseness. Two weeks before admission he had a sharp pain in the right side of the chest aggravated by coughing and deep inspiration, dyspnoea becoming pronounced at the same time. Had been unable to sleep, because of excessive pain and dyspnoea and was able to lie only upon the left side, the right side and back were exquisitely tender, no hæmoptysis. He had night sweats on two occasions, nocturia twice nightly. He lost about fifteen pounds in weight.

*Physical Examination.*—Male, adult, colored. Apparently fifty-five years of age. Undernourished, weak and in evident pain and dyspnoea, with hoarse voice and brassy cough. Right pupil fixed, left reacted sluggishly to light. There was a marked tracheal tug, visible from the foot of the bed. The physical signs of aneurysm were evident in the thorax. There was a definite pulsating point at the second to third rib level on the left side. Heart sounds were accentuated at the apex, the first sound being roughened, a murmur replaced the aortic second sound. The left shoulder, arm and forearm were swollen, there was marked venous congestion of this extremity extending up the left side of the neck and face and down the left side of the thorax for a short distance, the pulse at the left radial was weaker than the right. Blood pressure in the right arm 170/100, in the left arm 180/110.

## ANEURYSMS THORACIC AORTA AND INNOMINATE

### *Oscillometric Index.*—

	Right	Left
Arm .....	10.0	9.5
Thigh .....	5.0	5.0
Leg .....	4.0	3.0

The stronger readings on the right arm seem to indicate more force to the arterial impulse or that there was some hindrance of force in the left arm. It was also noted that the needle after each reading would swing over to and then pass centre; this was evidently due to the original impulse from the cardiac contraction and arterial recoil, the added negative impulse being due to the back surge into and the impulse of the aneurysmal sac.

*Fluoroscopic Examination.*—There was marked dilatation of the entire horizontal portion of the arch of the aorta with some involvement of the ascending arch and little or no dilatation of the descending part.

Wassermann, plus 4—Kahn, plus 4.

At operation the carotid artery was found thickened soft and tore readily. Post operatively blood pressure was 140/100 in the right arm—140/100 in the left arm, but the impulse was weaker than in the right arm.

The patient stated that pain had entirely disappeared from the thorax and back, and except for about three transient stabbing pains during the first four hours after operation he had not experienced any. Dyspnoea had entirely disappeared. He was able to sleep. Previously he had been unable to sleep for about two months except fitfully and was now able to lie and sleep upon his back and right side, heretofore impossible, due to exquisite pain.



FIG. 13.—Case VII. Röntgenogram, before operation.

The patient made a statement of his sensations during the operation, as a result of pre-arranged signals. At the control of carotid (arterial) supply (signal) patient noticed slight ringing in the left ear, a slight sensation of dizziness and a slight visual disturbance in the left eye described as a "light (illuminated) gray haze, like a circle and bright and dark spots." He also noticed some numbness on the left side of the face and the right side of the body for an instant. Motor functions were tried (signal) and we noticed no loss of the motor function of either extremity on either side. Nor was the patient cognizant of any pain.

At the release of anastomosis (signal) he stated that he felt some tightness in the left side of his neck and in the left apex of lung (pointing) near the sternum. He stated that he felt "tight and full" on the right side of chest, which persisted for only a few minutes. He noticed (signal) that the pain that he had had for two months below the right breast and in the back had disappeared entirely.

*Progress.*—Three days after operation, he had an attack of extra systole occurring at 11 A.M. and lasting three hours. Heart then became normal in rate and rhythm.

Later progress was good, rapidly improving; hoarseness had entirely disappeared in five days. Swelling of left upper extremity decreased in size—slowly.

Röntgenogram in ten days showed marked decrease in size of aneurysm and heart. (Figs. 2 and 3.) On May 9, 1929 (twenty days after operation), patient was discharged to receive clinical treatment once weekly. He had gained about eight pounds and walked all day long, absolutely free from pain, dyspnoea and hoarseness.



It was noted that post-operatively, and for three days, that this patient had profuse perspiration, limited to the right side of the face, sharply demarcated in the mid-line. Also there was increased lacrymation of the right eye that was evident for about seven days. It was also noted that the pulse before operation was around 80. During operation, after release of the circulation, it increased in rate to 100. It maintained this rate for several days and then during a period of fifteen days, gradually descended to 80 again, at which it has remained.

This patient was discharged from the hospital in apparently good condition, and when seen on several follow-up visits to clinic seemed well. He was last seen September 15, 1929. He was then symptom free. Blood pressure was 140/100 on both sides. Pulse was equal on both sides. He was taking active anti-syphilitic treatment.



FIG 14 —Case VII. Autopsy specimen Notice size of clot and anastomosis

CASE III.—B. M., colored, male, aged fifty-four years Admitted to Philadelphia General Hospital April 23, 1929, complaining of pain in the left axilla and back.

*Previous History.*—Patient stated that he was entirely well until about three years ago, when he slowly developed pain in the precordial region. He was treated at this time for rheumatism and indigestion. Pain recurred intermittently until April, 1928, at which time it became very severe, causing him to stop work. In September, 1928, he was suddenly seized with severe paroxysms of shooting pain in the left axilla and back. Pain was accentuated by motion, but not by coughing or eating. He became progressively worse and has lost about thirty-four pounds in weight. He had been confined to bed for the past eight months because of severe pain and dyspnoea. Denied venereal infection.

*Physical Examination*—Poorly nourished male. Complaining of severe pain in the back and left side and lying upon the right side with the thighs and legs partly flexed, the eyes showed no gross abnormalities. There was no tracheal tug. In the thorax there were suppressed breath sounds posteriorly at the left apex and left base which became louder after coughing. No râles were heard.

## ANEURYSMS THORACIC AORTA AND INNOMINATE

*Heart.*—The apex beat was not seen or felt, there was no shock, thrill nor abnormal pulsation. Rate and rhythm were regular and normal. The aortic second sound was greater than the pulmonary second sound. There were no murmurs. The patient had marked pain on percussion over the spine between the scapulæ and in the left chest (mid-axillary region). Left radial pulse was softer than the right and the arteries were found to be sclerotic. Blood pressure in the right arm was 90/70 (weak) in the left arm 110/80 (strong).

*Fluoroscopic Examination.*—Shows large saccular aneurysm of the transverse part of the arch of the aorta with the largest dilatation extending to the left. There is marked dilatation of the ascending and part of the descending branch also. The patient is in great distress from dyspnœa and pain. Cries with pain at all times.



FIG. 15.—Case VII. Autopsy specimen. Notice size of clot and anastomosis.

### *Oscillometric Index.*—

	Right	Left
Arm .....	7.0	8.0
Forearm .....	4.0	4.0
Thigh .....	4.0	5.00

Wassermann.—Neg.—Noguchi. Plus 3—Cholesterol antigen.

Operated on May 14, 1929. After the anastomosis was completed there was slight oozing of blood. This was closed over with continuous sutures. Both the vein and the artery were very large before separating the sheath. There was some decrease in size after stripping. The artery was very soft, resembling tissue paper. The vein became markedly engorged from the reflux from the right heart after release of tapes. The anastomosis functioned perfectly. Both artery and vein filled easily and the size became normal. The arterial stream could be felt impacting over, but there was only a slight aspirating effect evidenced by the vein. The incision was closed. The pulse became strong on the right side where it previously had been weak. The rate was

the same on both sides and apparently as full on one side as on the other. During operation the pulse rate increased from 100 to 138 when the sheath was cut and the artery tied off. Gradually it decreased in rate during operation to 100, at which point it was when the operation started. Blood pressure became 110/80 in each arm. Patient was definite in stating that his pain ceased at about the time of the completion of the anastomosis, and the release of circulation. There were no evidences during operation of cerebral, pulmonary, cardiac nor renal disturbances. Commencing during operation and for about one hour afterwards, the patient showed marked perspiration of the right side of the face and the body—sharply demarcated in the centre of his forehead and face.

May 15, 1929.—The patient had been apparently comfortable, the pulse remaining around 100 and regular, until 3 P.M. (twenty-seven hours after operation) when he started to complain of pain again, at the previous site, but stated that it was an "easy" pain and not nearly as severe as before operation.

May 15, 1929.—Seen at 1 A.M. because of severe pain in the back and the side at the site of previous pain.

May 16, 1929.—Pain still present, but not as marked. Blood pressure 110/80 in each arm. The pulse is of equal volume and rate at each wrist.

May 17, 1929.—Patient states that the pain is not as marked as previously.

May 18, 1929.—Blood pressure in each arm 110/80. Pulse is of good volume and rate. Patient now sleeps well and lies upon his back and the left side, something he has not done for over eight months. He can be percussed heavily over back and left side, over areas which were painful even to touch before operation.

May 20, 1929.—The perspiration has been absent for four days, but the right eye is still lacrimating.

May 23, 1929.—Pain gone, sleeps well, sits up in bed, looks better. Around in wheel chair and walks to bath room. Still is weak. Blood pressure in each arm 110/80.

May 25, 1929.—Patient is improving. He complains of slight pain on the opposite side of thorax from where it was previously. No bruit is present over the anastomosis; but cardiac beats can be heard through it. Lacrymation of right eye at the outer canthus is still present.

May 28, 1929.—There is no shortness of breath. Patient now walks about for short distances with no discomfort.

May 31, 1929.—Patient discharged from the hospital, much improved, no pain and is contented. Visits clinic every week and is steadily improving.

September 10, 1929.—Patient still visits clinic to take anti-syphilitic treatment and improvement continues.

CASE IV.—T. B., colored, male, aged fifty-four years. Occupation: stevedore. Admitted to Jefferson Hospital January 31, 1928.

*Chief Complaint.*—Pain in centre of the neck and on the right side, extending up above the ear and into occipital region. Pain in the right chest from the clavicle down to the fourth right interspace anteriorly and shooting back to the scapular region.

*Previous History.*—Apparently normal. Laborious work all his life. Acknowledged that he had a chancre fifteen years ago. Had an urethral discharge thirty years ago.

*Present Illness.*—Worked hard as a stevedore until August 30, 1927. At this time he was caught between two heavy bales of cotton and was crushed in the chest and abdomen. He had difficulty in breathing for several moments, but was not sent to the hospital. He has not worked since the accident, because of pain in the chest, which becomes progressively worse. During December, 1927, patient noticed a small right supra-clavicular growth and about the same time he noticed pain that extended into the neck on the same side. There was pain in the right chest radiating upwards to the ears and back to the occipital region. The pain was increased by effort.

## ANEURYSMS THORACIC AORTA AND INNOMINATE

*Physical Examination.*—Pupils re-act sluggishly to light and accommodation.

*Chest.*—Expansion limited because of pain. No irregularities otherwise. No swelling on chest, but in episternal region, slightly to the right there is a pulsating tender mass; there is marked carotid pulsation on the left. No bruit is heard. The lungs are resonant throughout, except in the right posterior axillary region, which shows slight impairment.

*Heart.*—Faint metallic-like systolic murmur heard at the apex, but not replacing the heart sound. The aortic second sound is accentuated; there is a faint diastolic murmur like a roughening at this area. Blood pressure—190/100 on admission.

*Progress.*—Patient continued to complain of pain since admission. Later patient seemed to become weaker and had several attacks of dysphagia.

February 25, 1928, the patient expectorated about two drachms of blood. He felt better after this for several weeks.

The radial pulse has been synchronous on both sides and of equal volume. Blood pressure has been equal in both arms.

*Röntgenogram and Fluoroscopic.*—Along the mediastinal aspect of the right upper lobe of the lung there is a distinct enlargement which pulsated under the fluoroscope believed to be due to an aneurysmal enlargement of one of the vessels, probably the innominate. The aorta is dilated and tortuous. The heart is just a little larger than average. Wassermann, plus 4, both antigens. Patient was discharged to Clinic.

Second admission, April 1, 1929. Admitted complaining of choking and swelling sensation in the neck, some substernal pain and palpitation, weakness and dyspnoea on exertion. Since discharge in 1928, patient has been making visits to the medical Out-Patient Department and was given potassium iodide. He has not been taking mercury, arsenic or bismuth. Has not worked, but has become progressively weaker within the last month or two. Pain in the sternal area has become aggravated. Lately he has had a feeling of fulness in the neck which makes him want to cough and swallow, but which hurts severely when he does either.

The trachea is slightly displaced to the left by a large, soft mass arising from beneath the sternum and clavicle. It is expansile and heaving. Between the sterno-clavicular synchondrosis and the trachea, it arises 2.5 centimetres above clavicle and is 3.5 centimetres in width. There is a bruit over it. The carotids pulsate markedly. No tracheal tug. No stiffness of the neck. The heart and lungs apparently are unchanged from previous findings.

Radial pulses are full, strong and regular, but the left is weaker than the right. Moderate degree of *sclerosis*. Blood pressure in the right arm was 128/96 and in the left arm 160/115.

*Röntgenogram.*—The enlargement along the mediastinal aspect of the right upper chest is still present due to the aneurysm reported on last admission.

Patient operated on. The artery was thickened and mushy. Convalescence uninterrupted. Condition good. Pain gone, breathes and swallows more easily. Discharged. Bruit well heard over the area.

June 20, 1929, *Röntgenogram.*—Subsequent to operation, no change. Blood pressure in both arms 120/70.



FIG. 16.—Case VIII. Röntgenogram, before rupture.

September 13, 1929.—Patient has been carefully followed in Out-Patient Department. He has shown some œdema of the legs at various periods, which clears up under medical treatment. His surgical condition has remained satisfactory since operation. There is no pain, dyspnoea nor dysphagia.

CASE V.—J. S., aged forty years, colored, male. Occupation: stevedore. December, 1928, the present illness began with a cold which persisted. There was a cough, but no pain. In February, 1929, shortness of breath on climbing stairs began to manifest itself. March 14, 1929, there was sudden onset of pain in the chest increased by lying down, constant, beneath the heart, and not affected by eating. There was marked palpitation. The cough has been non-productive. There has been no hæmoptysis, nor



FIG. 17.—Case VIII. Autopsy specimen. Showing size of sac, organized clot and point of rupture

night sweats. Denies chancre, but had Neisserian infection in 1909. His wife has never been pregnant.

*Physical Examination.*—He is a well-nourished, colored male. Dyspnoëic and coughs constantly. Lung resonance is impaired over both upper lobes. Breath sounds are bronchial on the right side and distant on the left side. No râles.

*Heart.*—Is not enlarged. There are no murmurs. Blood pressure in the right arm 80/60 and in the left arm 85/60. There are signs of pressure on larynx. He was transferred from tuberculosis ward to the surgical ward for exaïresis of phrenic nerve, because of persistent hiccough. Operation was performed April 3, 1929.

April 12, 1929.—Patient has been feeling well since operation. Brassy cough persists. Sputum is negative for tubercle bacilli.

May 4, 1929.—Hiccoughs have been present for several days. The sputum is blood streaked. Thoracentesis revealed no fluid. After this procedure, there was weakness and paraesthesia of the left leg for thirty minutes. Physical signs showed evidence of pressure on left bronchus, with interference to bronchial drainage and some atelectasis

## ANEURYSMS THORACIC AORTA AND INNOMINATE

Arterio-venous anastomosis was suggested. The patient refused operation. Blood Wassermann, plus 4, both antigens.

Following a paroxysm of coughing there was a sudden hæmorrhage from the mouth and nose. Several large clots were pulled from the throat, and the patient died immediately after the hæmorrhage.

*Röntgenogram* shows an aneurysm involving the ascending branch of the aorta, the horizontal part of the arch principally and possibly the innominate artery.

*Autopsy.*—(Extract.) Pericardium: There were patches of adhesions between parietal and visceral layers. The sac contains no excess of fluid.

The heart is small, soft, pale red; shows very little epicardial fat, except over



FIG. 18.—Case IX. Röntgenogram, before operation.



FIG. 19.—Case IX. Röntgenogram, after operation. Notice clearance of lung field; previously bronchiectatic. Also decrease in size of the aneurysm.

anterior surface of the right ventricle. It was removed "en-masse" with the aorta, trachea, esophagus and lungs. The myocardium was found to be pale, reddish brown and very flabby. The aortic cusps show wrinkling and fenestration of the right posterior aortic cusp. The coronary vessels are widely patent.

About 3 centimetres above the aortic ring is found an aneurysmal dilatation which bulges down towards the hilus of the left lung. It is 6 centimetres in diameter and filled with a laminated clot. In the wall of the aneurysm there is a ragged opening, large enough to admit two fingers. This communicates with the left bronchus. The transverse arch of the aorta at the point of origin of the innominate artery, shows a second and slightly smaller aneurysmal sac, 5 centimetres in diameter and like the ascending aorta shows pearly white nodular swellings and puckerings.

*The Trachea and Bronchi* contain in their lining thick, tenacious bloody mucus and blood clot, particularly the left bronchus, the wall of which is completely eroded, about 2 centimetres below the bifurcation, making a communication with the aneurysm of the ascending arch of the aorta, already referred to. Esophagus—no erosion.

There was nothing abnormal found in the brain. The Circle of Willis was large, complete and patent.

CASE VI.—M. J., colored, female, aged thirty-two years, housekeeper. First admission April 16, 1928. The patient denied venereal infection. Had no pregnancies. Complained of pain in the back of the neck and radiating down through the shoulder

and into the right lung. Three months before admission, she contracted a severe cold, causing her to cough severely but persistently unproductive. Shortly after onset the neck became quite painful in the vicinity of the right sterno-clavicular junction. Pain radiated down the right shoulder and apparently into the right lung. It was throbbing in character, similar to a toothache and constant. Three weeks before admission she noticed a swelling, just above the junction of the clavicle and manubrium on the right side, which she attributed to her cough. This swelling is about the size of a half dollar and has an expansile pulsation.

*Physical Examination.*—The patient is an adult, colored, female, not acutely ill. The eyes react normally to light and accommodation. The pupils are equal and regular. Just above the junction of the right clavicle and manubrium there is a swelling with expansile pulsation. There is a marked thrill on palpation. Auscultation elicits a systolic murmur in the swelling itself and in the carotid. There is no cervical adenopathy. There is no thyroid enlargement.

*Thorax.*—Crepitant râles are heard at bases, laterally and anteriorly in both lungs. The heart borders are within normal limits. There is no increase of post-manubrial dullness. There is no palpable thrill. Rate and rhythm were regular. A loud systolic murmur is heard at the aortic area and is transmitted to the vessels of the neck. Blood pressure in the right arm 80/0 (?); in the left arm 150/90. *Impression.*—Aneurysm of innominate artery.

The patient left the hospital of her own volition. She was re-admitted December 26, 1928, with the same complaint. The pain now extends down the right arm. Her physical condition was essentially the same as before. There was no tug. A provisional diagnosis of toxic goitre was made at this time. The blood pressure in the right arm was 0/0, and in the left arm 148/98. The basal metabolic rate was plus 25, plus 14, minus 6 on three successive days. Blood Wassermann: plus 4, both antigens.

*Röntgenogram.*—Aneurysm of aorta and innominate were present. (Fig. 11.)

The positive findings at this time were: 1. Emotionalism. 2. Tachycardia with slight hyper-pyrexia. 3. Tremor of hands and tongue. 4. Exophthalmos (?). 5. Slight lagging of upper lids. 6. Lateral nystagmus. 7. Rapidly enlarging right sided supra-clavicular swelling, tender expansile pulsation in swelling. 8. Obliteration of radial pulse, right side. 9. Pressure symptoms.

Marked relief of pain was procured by use of iodides. The size seemed to reduce under treatment. Subsequent progress showed that the mass apparently increased to the left and diminished to the right. Later it increased to the size of a large lemon. The patient insisted again upon going home.

April 24, 1929.—Re-admitted, the patient's symptoms were the same as before, but more marked. The mass has increased in size and now protrudes above the episternal notch like a small apple.

The physical examination is essentially the same as before, excepting that there is a small area in the mass that pulsates most markedly and seems to be about to perforate. Over the aneurysm there is a definite shock on systole. The first and second heart sounds are well heard over the tumor; a faint systolic murmur is also heard. A rough systolic murmur is heard over both carotids. The apex beat is visible and palpable in the fifth interspace. There is a heaving precordial impulse. No thrill is distinctly present. There is a diastolic shock at the base and in the supra-cardiac region, particularly at the left. The heart is slightly enlarged to the left. There is a marked increase in supra-cardiac dullness. The sounds are forceful, and of good quality. The rate is rapid and the rhythm regular. There are no murmurs. The pulse is barely perceptible in the right arm. The blood pressure in the right arm is 0/0; and in the left arm 180/100. In the lungs there are harshened inspiratory sounds throughout. There are no râles.

*Operating Notes.*—The patient was considered a very poor operative risk with a

strong possibility of death on the table. The aneurysm is now definitely pointing above the episternal notch. The patient has marked respiratory embarrassment.

The operation was started under local anæsthetic. The patient became uncontrollable and voiced a premonition of death. Gas anesthesia was resorted to. The anastomosis was about completed when the patient stopped breathing. The heart stopped beating and adrenalin was given into the ventricle of the heart which started to beat forcibly. Artificial respiration failed to stimulate breathing. Oxygen CO<sub>2</sub> and alpha lobelin were used. Twenty minutes later the heart stopped again. Adrenalin injected into the ventricle failed to cause reaction. The patient was declared dead.

*Autopsy Findings.*—Just above the right sterno-clavicular joint, the skin was separated with difficulty from the underlying tumor mass, and a small incision was made into the mass. The right sterno-clavicular joint was slightly separated. Further dissection showed the tumor to be a dilatation of the innominate artery. The right subclavian and the right common carotid artery at their origin from the apex of the aneurysm were separated by a distance of one inch. The anterior part of the aneurysmal sac was very close to the skin and had eroded the upper end of the sternum and the inner end of the right clavicle. The posterior wall of the aneurysm partially compressed the trachea which was not adherent to the aneurysmal sac. The ascending portion of the aorta was not dilated. A small part of the transverse arch at the origin of the innominate was dilated. The sac contained a spherical, laminated clot, with a central channel about 1.5 centimetre in diameter. Its anterior wall showed no remains of the vessel wall, being composed of tough fibrous tissue.

The arch and the descending portion, to the bifurcation shows a loss of the normal yellowish, glistening appearance of the intima. The surface is wrinkled longitudinally and there are many pearly, slightly elevated plaques. About the coronary openings and the openings of the lower branches there is a slight atheromatous change.

*Brain.*—The meninges show the adhesions and changes of an old syphilitic meningitis. The Circle of Willis is complete but small, some of the branches being hair like.

*CASE VII.*—J. G., colored, male, aged forty-five years. *Chief Complaint.*—Pain in the left side of the chest and back. The pain has been present for one year. The patient has been unable to work since January, 1929, because of pain. It is present in the left axilla and beneath the left scapula, at times it descends to the fingers down the left arm. It is made worse by moving about in bed, and is relieved by lying on the right side. The pain is not affected by coughing, breathing nor swallowing. There are no cough, expectoration nor night sweats. There is no precordial pain, nor œdema of ankles. There has been a loss of twenty pounds in weight during the past six months. The patient admitted having a chancre fifteen years ago, but took no treatment for it. Vision is poor in the left eye. There are no other symptoms.

*Physical Examination.*—The patient is an emaciated colored man of forty-five, lying on his right side and complaining of continuous pain in the left chest. The right pupil reacts to light; the left pupil is small and fixed by a synechia of an old iritis. Marked pulsation of the right carotid artery is visible. There is no tracheal tug. There is no evidence of motor disturbance. Lung expansion is limited on both sides. Breath sounds are diminished. There are no râles. There is no impairment of resonance. The heart is not enlarged to the left. The sounds are of fair quality. There is no apical murmur. At the aortic area there is a systolic thrill, a roughened first sound and a snappy, loud second sound. Post-manubrial dullness at the second rib is increased in width to the right and left. At the left scapula there is tenderness on percussion and the heart sounds are heard. There is no transmission of sounds to the vessels of the neck. The radial pulse on the right side is full and regular, the left is very weak. The left hand is not cold, however. Blood pressure in the right arm was 128/90 and in the left arm 60/0. There is voluntary rigidity of the abdomen. Pulsation of the abdominal aorta is felt. The blood Wassermann is plus 4.

*Fluoroscopic.*—The greatest dilatation involves the transverse portion of the arch



with some enlargement of the ascending part. The greatest point of dilatation of the sac is to the left. There is obstruction of the left subclavian and left brachial. The pressure of clot occlusion is on the left side.

This patient was considered pre-operatively as a very bad risk, and also had a premonition of death.

May 14, 1929—Operative notes and course. The artery was very small and of fair pulsation. The vein was very small in calibre. Both decreased further in size after stripping of the carotid sheath. The pulse was 84 to 90 before the circulation was released. The rate increased to 120 after release of the tape and restoration of the circulation. Both the vein and the artery were functioning, though the vein did not engorge from the back pressure or "reflux" from the right side of the heart at systole, but it did show the aspirating effect during the diastole, to some extent. The patient was



FIG 20—Case IX Autopsy specimen Notice erosion into trachea

very restless during operation. The patient was indefinite as to the time of cessation of pain in the thorax, but stated positively on the operating table that the pain was gone from his thorax. After the incision was closed, the pulse in the left arm, that had been absent previous to and during the operation was found to be present and palpable, although weak in character. There were no cerebral, pulmonary, renal nor cardiac disturbances evident during the operation, but for about one hour after operation, the patient showed profuse cold perspiration of the right side of the head, as sharply demarcated as though a line had been drawn down the centre of forehead, nose and chin. The blood pressure was not taken until three hours after operation and was 110/80 in the right arm and absent in the left. The pulse still came through occasionally in the left side. Marked lacrymation of the right eye was present.

May 15, 1929—The patient developed a right sided hemiplegia some time between 11:00 P.M. and 8:30 A.M. He was perfectly conscious, smiled and showed no evidence of pain. The right side of the face was completely affected. The tongue protruded to the right. Sensation was not impaired. The patient understood questions and answered by smiles or nods, but was unable to speak. (Later) May 15, 1929.—The patient seemed cheerful, but could not speak. He attempted to help himself to move

## ANEURYSMS THORACIC AORTA AND INNOMINATE

around in bed. The entire right side of the head perspired freely. The left side of the face showed no perspiration. May 15, 1929 (Later).—The pulse rate increased rapidly to 140 at 1 A.M. and became very weak in character. The blood pressure in the right arm was 110/80 and in the left arm was absent. Pulse was now absent in the left wrist. The temperature rose. There was definite dullness in the left apex with bronchial breathing, extending down to the eighth rib. There were no râles. Above the clavicle on the left side could be heard the rapid to and fro bruit of the functioning anastomosis. It was very loud this morning and was not present yesterday. The patient seemed cheerful and smiled when spoken to, but his condition was regarded as critical.

May 16, 1929.—The bruit of the functioning anastomosis had disappeared. The pulse was very weak and rapid, and came through feebly at the left radial artery.

May 16, 1929.—The patient died one hour later.



FIG. 21.—Case IX. Autopsy specimen. Notice erosion into trachea.

### *Oscillometric Reading.*—

	Right	Left
Arm .....	6.0	1.0
Forearm .....	2.0	1.0
Thigh .....	3.5	3.0

Blood serology—Plus 4, both antigens.

*Autopsy Extract.*—The transverse portion of the aorta is expanded to form an aneurysm which tends upward on the left side of the vertebræ to the sixth cervical. The ascending portion of the aorta is slightly dilated. At the beginning of the transverse portion, the aorta is expanded to form an aneurysmal sac which includes the entire transverse and descending portions of the arch for a distance of 10 centimetres. The ascending part of the aorta is 4 centimetres in diameter, at the origin of the innominate; the greatest diameter of the sac is 7 centimetres, just distal to the origin of the left subclavian. The descending aorta is not expanded. Proximal to the greatest dilatation of the sac are given off the innominate artery, the left common carotid artery and the left subclavian artery. Distal to these branches the sac is greatly expanded, extending

upward beyond the clavicle. The left common carotid and the left subclavian arteries thus arise to the right of the mid-line and cross over the top of the aneurysmal sac. The left phrenic nerve crosses over the anterior surface of the aneurysm and is closely adherent to its surface. The trachea and the œsophagus are slightly displaced to the right and are not compressed. The pulmonary artery is adherent to the sac of the aneurysm. At the point of adhesion, there is a small aneurysmal dilatation, about 1.5 centimetres in diameter in the wall of the aorta. The posterior wall of the sac is formed by the bodies of the second, third and fourth thoracic vertebræ. The left half of the bodies of these vertebræ are deeply eroded. The intervertebral discs are preserved. By removing a thin layer of soft necrotic tissue, the spinal cord is exposed. Two intercostal nerves are exposed for a distance of 2 centimetres from their origins. None of the aorta is preserved in the posterior wall of the aneurysm.

The sac in its upper expanded portion is filled with a dark red, friable, laminated thrombus. The lower part of the sac is free from thrombus and gives a wide passage for the blood. The floor of the aorta in the transverse portion is sacculated by three small aneurysmal dilatations. The innominate and left common carotid arteries have a common orifice at the expanded portion of the sac. The orifice of the left subclavian artery is not open. It is covered by an extension of the large laminated clot which occupies the greater part of the aneurysmal sac. The ascending portion of the aorta has an intimal surface that is puckered, showing fine longitudinal wrinkles and small scars.

In the brain there was an area of softening on the left side of the cerebrum embracing the motor and sensory areas and extending to the inferior surface of the frontal lobe and including part of the temporal lobe. Cut sections show evidence of congestion, but no embolus was found within the arteries.

The Circle of Willis was normal, large and patent with many collateral branches being given off.

CASE VIII.—R. A., aged fifty-three years, colored, male. *Chief Complaint.*—Had pain in the chest and shortness of breath. Illness started about a year ago with a cold, during which he was confined to bed for four weeks. He has had a chronic cough since then which has grown worse; also increasing hoarseness. Occasionally he brings up small amounts of bloody sputum. He has had pain in the left upper chest for the past two or three months, and also complained of severe dyspnœa. There has been a loss of forty pounds in weight during the past year. His wife is living and well, but has never been pregnant.

*Physical Examination.*—The patient is a poorly nourished, colored male, fifty-three years of age, with pain in the chest and marked dyspnœa. The scleræ are muddy, and oral hygiene is poor. There is limited expansion of the left side of the thorax. There is a heaving impulse and fullness over the upper chest. There is flatness over the left upper chest from the sternum to the mid-clavicular line. Breath sounds are distant over the left lung and exaggerated over the right lung with many bubbling râles at the right base; and crackling râles at the left base. The heart is slightly enlarged; the sounds are of poor quality. There is a systolic murmur at the apex. The aortic second sound is greater than the pulmonary second sound. Sounds well heard over the left upper chest. The blood pressure is 110/80 in the right arm. The pulse is absent in the left arm. There are many small scars over both legs. The patient grew much worse and died about six hours after admission.

*Röntgenogram.*—There is a very large fusiform aneurysm of the aorta. The trachea is displaced to the right. The Wassermann is plus 4, in both antigens.

*Autopsy Extract.*—The body is that of a considerably emaciated, fairly well developed, senile male negro, about sixty-three years of age.

The pericardial sac contains about 100 cubic centimetres of slightly cloudy, yellowish fluid. In its upper portion, the sac is adherent to an aneurysmal sac. There is a slight amount of plastic material present in this region. The entire anterior, middle and pos-

## ANEURYSMS THORACIC AORTA AND INNOMINATE

terior mediastinum, in the upper portion, is occupied by an extremely large, soft mass which is later found to be aneurysmal sac.

The heart weighs 300 grams. The heart is small—particularly in comparison to the size of the aneurysm. The coronary arteries are thickened and sclerotic. The muscle of the left ventricle is small and pale; that on the right is extremely thin and is also pale. The cavities of both ventricles are slightly dilated. The valve leaflets show no particular abnormalities. About one inch above the aortic valve, the aortic lumen expands into a tremendous size aneurysmal sac involving the remainder of the ascending arch and the complete transverse arch to the bend of the descending arch. The aneurysm measures 15 x 16 x 10 centimetres; it is fusiform in character and is partially filled, more particularly in its upper portion, by a thrombus which, at the attachment to the aortic wall, shows partial organization since it is somewhat adherent in this region. In the lower portion of the sac, there is a considerable quantity of clot, but the lumen in this region is extremely narrow and short so that communication between the first portion of the aorta and the descending arch must have been very narrow.

The aneurysmal sac is attached by adhesions in its upper portion to the apex of the left lung which is separated with considerable difficulty. The left lung is pushed forward in the chest cavity and is somewhat atelectatic. Posteriorly, the sac has compressed the œsophagus somewhat. It has eroded into the œsophagus, with production of a large ulcer about 1 centimetre in diameter. There is, however, no direct opening into the aneurysm and no signs of blood in the œsophagus. The pulmonary artery, where it divides and passes into the lungs, shows constriction as a result of the aneurysm.

The intima of the aorta, in the first portion, shows slight wrinkling, but in the descending portion, it is extremely thickened and irregularly puckered and wrinkled and shows some degree of atheroma.

Right lung: weighs 730 grams. This organ is large, somewhat emphysematous. There is a moderate degree of congestion involving all lobes.

Left lung: weighs 300 grams. The lung is atelectatic. Cut section is pinkish red; it shows no special abnormalities.

In the brain, the Circle of Willis is not complete. There are no posterior communicating branches.

CASE IX.—M. W., white, male, aged forty years. Occupation: plasterer, was admitted to the hospital May 24, 1929.

Complaining of cough of eight months' duration. While asleep he was awakened with a choking sensation in the throat. He began to cough and expectorated a white, frothy sputum. This choking sensation lasted for several weeks and the patient became very dyspnoeic. The cough and dyspnoea have persisted since the onset, during which time he has lost about fifty pounds in weight. He has occasional brief periods of slight relief. There has been no hæmoptysis; nor any odor to the sputum. Neither the cough nor the amount of expectoration is affected by a change of position. Night sweats have been frequent. Loss of strength has corresponded to his loss of weight. He can breathe more freely while sitting up in bed. Admitted gonorrhea and syphilitic infection at the age of 20. He was treated for syphilis for eight months. His wife has had no pregnancies.

*Physical Examination.*—The patient is a slim, emaciated, anemic, white male, propped up in bed and in evident respiratory distress. The head moves with each beat of the heart. There is slight irregularity of the pupils. There is marked pulsation of the arteries of the neck. There is a bulge in the supra-sternal notch, expansile in character when the neck is extended. A very marked tracheal tug is visible. (Brassy cough, husky voice and frothy expectoration present.) The chest is thin and emaciated and marked atrophy is present. Expansion is fair and equal. There is no lagging. Tactile fremitus is present, but diminished over both apices. There is impaired resonance over both upper lobes, most marked on the right side, especially posteriorly. The breath sounds are harshened at the apices, gradually becoming soft and vesicular as

the bases are approached. Occasional râles are heard to the fifth left interspace from the mid-clavicular line to third axillary line, where many fine crackling râles are heard on deep inspiration. No apex beat is seen or felt in the prone position, marked epigastric pulsation is seen and left. Cardiac dullness is not increased to any great extent. There is no shock at the apex; there is a suggestion of a systolic blowing murmur extending into diastole. Over the aortic area, the sounds are replaced by a to and fro soft blowing murmur transmitted towards the left sternal border. A friction rub is heard in the sixth interspace. The pulse is palpable in both radial arteries. A systolic murmur can be heard over the femoral arteries. The pulse is collapsing in character—no Quincke's sign present. The blood pressure in the right arm is 118/40 and in the left arm 118/32.

*Abdomen.*—There is an epigastric pulsation, but no mass is felt.

On May 28, 1929, the patient was admitted to the Surgical Ward.

*Fluoroscopic Examination* showed a saccular aneurysm of the transverse portion of the aorta and marked tracheal tugging. Also, there was decided disease of the base and apex of the right lung.

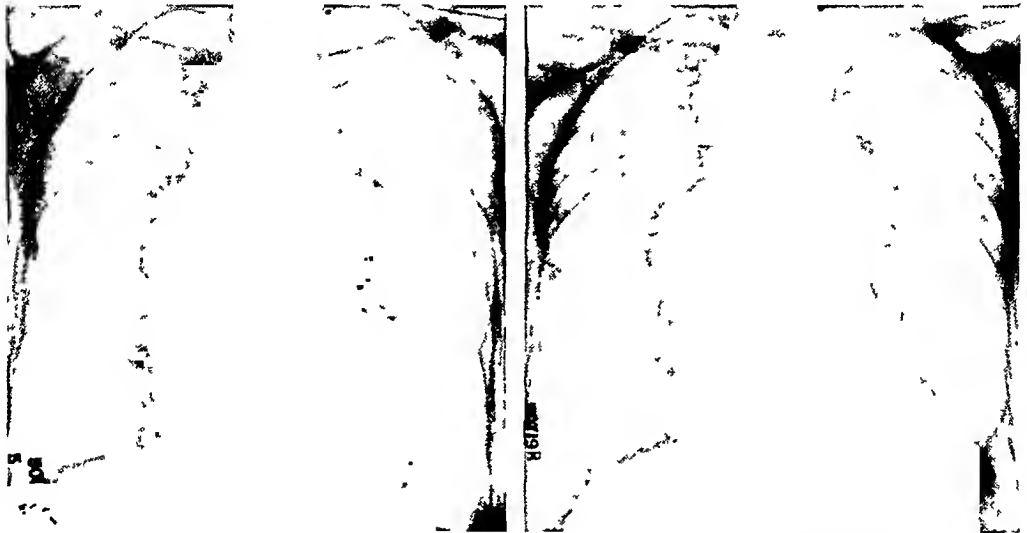


FIG. 22—Case X. Röntgenogram, before operation.

FIG. 23—Case X. Röntgenogram, after operation. Notice decrease in height of sac. Also decrease in width and size of heart.

The blood pressure at this time was 120/40 in each arm. The patient's breathing at this time was intensely stridulous, each breath being an effort and accompanied by retraction of all the interspaces, supra and infra-clavicular fossae and epigastrium. The signs of atelectasis of the right base are present.

*Röntgenogram*—There is a small saccular aneurysm involving the horizontal arch. At the right base there is considerable mottled density occluding the outline of the dome of the diaphragm on this side. There is also irregular density on the left base. Probably bronchiectasis.

June 7, 1929—Patient operated on. The anastomosis was completed and functioned well. The aspiratory effect of the vein was well shown. The artery was apparently normal. The patient had a severe coughing spell shortly after removal from the operating room and seemed very ill. The blood pressure was 170/60 in both arms after operation. During the operation the blood pressure (systolic) mounted gradually from 120 to 188, the highest point being reached just before the anastomosis was released. The pulse showed a corresponding rise from 130 to 170, the highest point corresponding to the time of the highest point in systolic pressure.

Both the blood pressure and the pulse began to decrease after the anastomosis was completed. No cerebral pulmonary, cardiac nor renal phenomena were observed.

June 7, 1929.—Both lung bases show definite disease, apparently the right is still collapsed at the base. The patient, however, seems more easy, and states that he has no pain. Seen during the night, he was apparently comfortable..

June 8, 1929.—The patient was seized with a very severe coughing spell at noon and since then has been very dyspnoëic. His day has been decidedly stormy, and he appears to be in extreme distress. The pulse has been around 150 and full. The blood pressure is 160/60 and his head bobs with each heart beat.

June 9, 1929.—The patient appears to be more comfortable. No stridor is present in his breathing. He now brings up large amounts of sputum (yellow and tenacious) with more ease than formerly. The blood pressure is now heard over the entire range of the manometer from 300 to 0, becoming accentuated at 140 and losing accentuation at 40. The pulse is very forcible; signs of collapse of the right base are still present. There are no râles.

June 10, 1929.—The patient became progressively worse. Breathing became clearer, but more shallow. The pulse became weaker as did the heart tone and general physical condition. The blood pressure in the right arm was 135/30, and in the left arm 150/0.

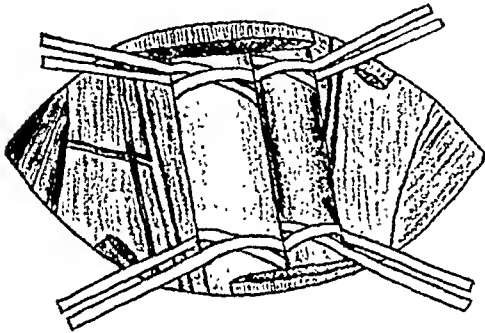


FIG. 24.—Showing application of tapes to control circulation.

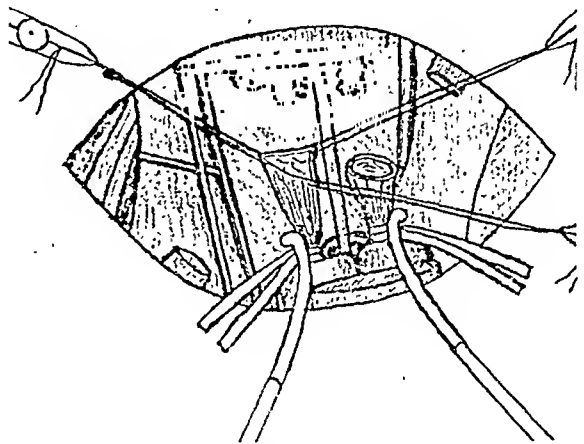


FIG. 25.—Showing vessels cut with distal ends ligated, proximal ends controlled and position of traction sutures.

June 12, 1929.—The general condition seemed somewhat improved. He breathed more easily, the pulse was more equalized. His color was better. He was coughing more freely. He has had one attack of stridor in the last two days that lasted only a few moments. Before operation, stridor lasted days. He can now eat solid foods and swallow liquids with ease. Over the right base where air was apparently absent before operation and until the last few days, there were definite breath sounds heard. No râles were heard in the chest. He seemed to be much improved.

June 26, 1929.—The patient is apparently improving steadily. He has no complaints. His color is good. He breathes more easily and has had no pain whatever. At 2 A.M. today the patient had a severe attack of dyspnoëa. He stated that he would die today. He was given medication with marked relief. At 8 A.M. he was seized with a second attack. His pulse and heart pounded violently. This was also relieved by medication. At 11:30 he was seized with a third attack in which he became very cyanotic and died in a few moments.

*Autopsy Extract.*—There is a large saccular aneurysm arising from the transverse portion of the aorta and extending up to about the seventh tracheal ring and in its greatest diameter pressing upon the trachea, about 2 centimetres above the bifurcation. At this point there was a large eroded area about 4.5 centimetres in diameter, working into the trachea and having partly destroyed several of the cartilaginous rings to such an extent that only a thin bulging sheet of tissue separated the lumen of the aneurysmal sac from the lumen of the trachea. The œsophagus showed no involvement.

There was a small, friable thrombus formation about .25 centimetre in length in the lumen of the anastomosed vessels at the line of anastomosis and built up around several of the sutures.

There was an organized clot involving the right heart and the right pulmonary artery extending into the vessel to well beyond its first bifurcation.

The right lung, base and apex showed marked bronchiectasis and there were signs of a sub-acute pneumonitis of the entire left lung.

The brain showed nothing abnormal. The internal carotid on the ligated side on being removed in whole, showed no clot formation and was entirely patent. The vessels of the Circle of Willis were patent, but remarkably small.

CASE X.—P. M., white, male, aged fifty-five years. Occupation: laborer. Admitted to the hospital May 21, 1929. *Chief Complaint*.—Pain in chest. About six months before admission the patient "caught cold." He began to cough and became hoarse. Cough and hoarseness persisted to the present time. Shortly after the onset the patient noticed that he became dyspnoëic on slight exertion and that he had substernal pain and discomfort. He continued to be up and about the house. About one month ago he began to have pain in his right upper chest anteriorly. This pain was

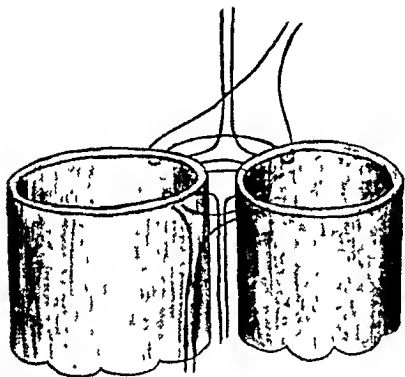


FIG. 26.—Method of suturing. Bringing intima to intima.

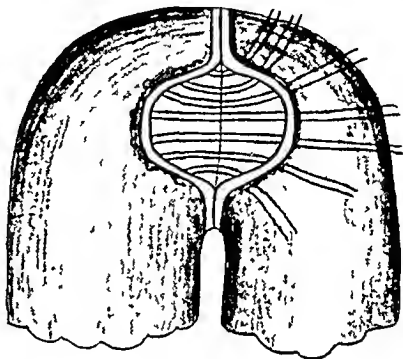


FIG. 27.—Method of suturing. Bringing intima to intima.

constant and became progressively more severe. When the pain became too severe, the patient sought hospital care. He has never had hæmoptysis. He admits having had a sore on the penis about 20 years ago.

*Physical Examination*—The patient is a poorly nourished male adult, apparently sixty-five years of age. The pupils are unequal, the left is irregular and both react sluggishly to light. A tracheal tug is present. Lung expansion is less on the right side. There is a slightly bulging mass about 2 inches in diameter present, just to the right of the sternum in the second and third interspaces. This mass has a definite expansile pulsation, most marked between the ribs. There is no thrill over the mass. The mass is tender to palpation. The lungs are apparently clear throughout.

There is flatness to the right of the sternum in the second and third interspaces as far out as the mid-clavicular line. The heart is enlarged, the sounds are of fair quality, the action is regular and there is a systolic apical blowing murmur. There is a double murmur at the aortic area and over the pulsating mass. Pulse volume in the left arm is better than in the right. The blood pressure in the right arm is 110/50 and in the left arm is 130/40.

May 28, 1929—The patient was transferred to the surgical ward for arterio-venous anastomosis. Fluoroscopic examination showed an immense saccular aneurysm involving the ascending, transverse and descending parts of the arch of the aorta. Sacculations from this point anteriorly to the chest wall on right and also involve the innominate.

*Physical Examination.*—There is impairment at both apices with bronchial breathing. There are some loud mucous râles at the right base. There is a loud to and fro murmur replacing both sounds at the apex and also over the xiphoid area. This is present also at the base of the heart, but more faintly. These murmurs are intense over the expansile mass on the right side. No shock nor thrill is present. There is a definite tracheal tug that is visible. The patient can only whisper and cannot swallow anything without great difficulty. The blood pressure in each arm is 170/40, Wassermann plus 4—both antigens.

May 31, 1929.—*Operative and post-operative notes.*—The vein was found to be of very large calibre. The artery was also of large calibre. At the cutting of the carotid sheath, the pulse increased from 100 to 120. There was no change in the blood pressure at this time. At ligation of the carotid artery and internal jugular vein the pulse again increased, this time to 140. There was a drop in blood pressure from 170/40 to 152/20. This was one of the low points in blood pressure. During the actual anastomosing, the pulse decreased gradually to 100 and remained there until the release of the circulation at which point it increased from 100 to 120. It remained at 120 for a short time and during the next hour, it gradually decreased to 100 at which point it remained for four

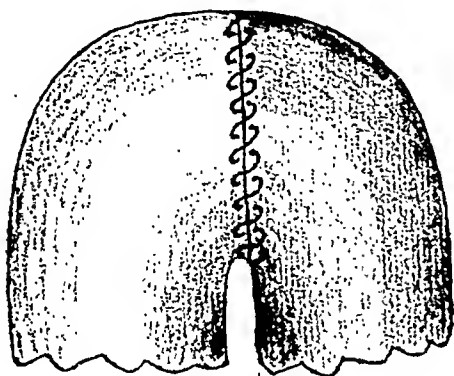


FIG. 28.—Showing continuous suturing of adventitia.

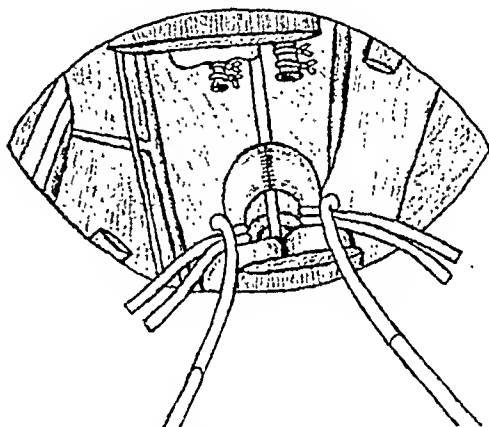


FIG. 29.—Showing anastomosis completed, before removal of controlling tapes.

hours, then decreasing to 90, of good volume and regular. It was noted during the operation that when the carotid artery was cut across the pulse dropped from 140 to 124. The artery was markedly atheromatous and very sclerotic. The intima seemed to be calcific in places. The adventitia peeled away readily from the vessel like an extra covering and the edge of the intima curled inwards at some points. The artery was so tough that many needles were broken; it was about four times thicker than normal. The anastomosis functioned well and the aspirating effect of the vein was clearly seen. The patient stated after operation that the pain in his chest had entirely disappeared. He was apparently very comfortable and showed no signs of cerebral, pulmonary, cardiac, nor renal disturbances. No difference in size of pupils could be noted. The blood pressure was 150/40 in both arms.

June 1, 1929.—At 2 A.M. the pulse rate jumped to about 130 but was of good volume. The patient was apparently comfortable. The temperature rose to 100. There was no arrhythmia and no dyspnoea. The blood pressure is 138/40 in both arms. The left was stronger than the right. The pulse was 94 of regular rate and good volume. He was able to swallow, without coughing.

June 2, 1929.—The patient was apparently very comfortable. He stated that he could now swallow more freely than before operation and that his breathing was less difficult. Previous to operation, he spoke in a whisper. He now spoke in a husky



audible voice. Pain was present again to slight extent over the right pectoral region, but very dull and nothing like it was before operation. This was probably pain from eroded bone surfaces. The blood pressure was 140/40 in each arm.

June 3, 1929.—The patient now swallowed foods and liquids with ease. The cough was much less. The right pupil was larger than the left. He slept well at night. The pulse was 90. The blood pressure was 120/50 in the right arm and 130/40 in the left arm, but the right arm was weaker than the left.

June 6, 1929.—There were occasional showers of extra systole. A bruit was heard clearly over the anastomosis. He is now up in a wheel chair.

June 8, 1929.—The patient had been complaining of occasional attacks of apnoea which did not persist very long. He stated that something seemed to swell in his throat and shut off his breath. A pulsating mass was still present and apparently not decreased in size. Talked and swallowed with ease.

July 10, 1929.—While walking around the ward, the patient suddenly complained of extreme dyspnoea and was put to bed, where he died suddenly one hour later.

No autopsy permission was given.

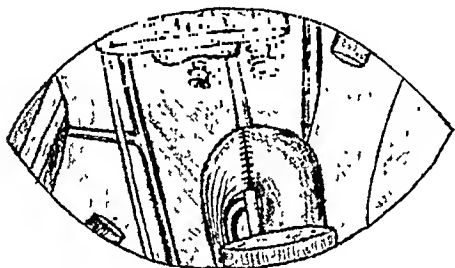


FIG. 30.—Showing tapes removed and appearance of vein in diastole of the heart.

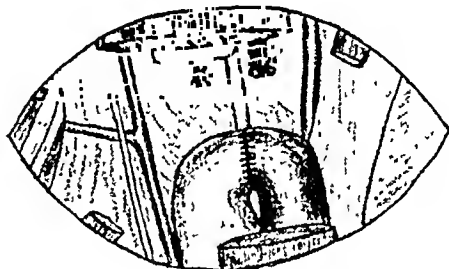


FIG. 31.—Showing the appearance of the vein in systole.

#### SUMMARY OF CASES

A review of the preceding cases show that the age of the individuals concerned ranged from 32 to 55, the patient of 32 being the only one below 40 and the only female in this series and incidently the only one that appeared no older than she was—the other nine appearing to be about ten years older than they really were. Each patient was engaged in a laborious occupation. Seven patients were negroes and three were white, although no selection of cases was made, but each one studied in the order in which it was received into the hospital.

Symptoms were apparent to the patients from a minimum duration of two months to a maximum duration of five years. Severe pain was predominant complaint in each case. In nine cases it was centered in the thorax and in the other case it was in the neck and right shoulder. The pain was so acute in some cases that sleep, other than fitful, was impossible for a period of months, large doses of Morphine Sulphate afforded no relief. All but one complained of dyspnoea and cough, and in two dysphagia was a prominent symptom.

Loss of weight was noticed in four cases; in one case the loss was over

20 pounds within a period of six months. In four cases a visible pulsating tumor was present and a tracheal tug was evident in two cases. Only five of the ten cases showed a difference in blood pressure in the two arms, in two the patients were pulseless in one arm.

Blood Wassermann was positive in each case.

All of the patients presented involvement of the aorta. Four patients showed an aneurysm of the innominate artery as well.

At operation, the common carotid artery was considered as normal in only one case; in other cases it was thickened or calcified; or soft and mushy.

In each case the marked and immediate relief of symptoms during operation was the outstanding feature—this fact alone justifies the operation.

*Mortality of Operation—Cause of Death.*—The immediate mortality in this series of cases operated on has been 25 per cent.

One case died on the table, as a result, according to the pathologist, of the effect of nitrous oxide upon an old syphilitic meningitis, it being contended that the damaged cells do not have sufficient vitality to recover from the anæsthetic. This fact emphasizes local anæsthesia as the method of choice.

One case died as a result of apparent embolism, the embolus in all probability having come from the ligated end of the common carotid artery. Curious to relate each of these patients had a pre-operative premonition of death, each stating to the attending physician and nurses that he or she would not survive. Of the two cases that died some time after the operations, one died suddenly, five weeks after the operation, while walking in the ward. This patient's myocardium was in very poor condition. The cause of death was given as cardiac failure, but was not proved by autopsy inasmuch as this was the only case in which a post-mortem permit was not obtained.

The other case was operated on while in a very precarious condition and following the operation was apparently comfortable. He was greatly relieved of pain and dyspnœa and there was marked improvement in the condition of his lungs, as confirmed by röntgenogram. Death occurred in a paroxysm of coughing, about four weeks after the operation. Post-mortem, as stated, showed erosion of the aneurysm part way into the trachea, with almost complete occlusion, just above the bifurcation of the trachea.

The other four that were operated on and lived showed marked improvement. As a means of comparison, one case J. S. (Case V) had not as much involvement as J. G. (Case II). The former refused operation and the latter consented. After three months, the former died from ruptured aneurysm and the latter was discharged, free from symptoms and a röntgenogram taken before and others taken ten, twenty and thirty days afterward showed marked decrease in size of both the heart and the aneurysm.

*Future of Operation.*—So far the total mortality in this series has been 50 per cent., but in view of the fact that all these cases heretofore would have been regarded as hopeless, death being inevitable within one or two months at the most, and that 50 per cent survived and were relieved, two being already back to work, points to definite value in this procedure and with

earlier diagnosis it is safe to prognosticate that this operation will be of immense value in heretofore hopeless aortic aneurysms.

*Cause of Cerebral Complications with Suggestions as to Prevention.*—Ligation <sup>41</sup> of common carotid artery has a definite morbidity and mortality, some intra-cranial complication, occurring in 20 to 25 per cent of the cases.

One-half the cases with complications die. The complication manifests itself with paralysis, aphasia or mental changes. Complicating symptoms usually do not appear until after the first twenty-four hours, then they occur suddenly. The cause of complications is debatable, it would appear to be embolic rather than cerebral softening due to impaired blood supply.

Dr. H. M. Richter and I have ligated the common carotid artery twenty-three times, with a cerebral complication in two cases and death in both. Symptoms did not occur until three days after operation in each case, then hemiplegia manifested itself suddenly.

All the cases we ligated were in patients of advanced years with severely diseased arteries, nearly all of the patients were suffering with extensive malignant diseases, these plus eight reported above make thirty-one cases with three deaths.

Lipshutz,<sup>42</sup> in his article on injuries of the large arteries sums up, succinctly, the reasons for cerebral complications: 1, Age and state of patient. 2, The presence or absence of change in the vessel wall. 3, The manner of application of the ligature. 4, Variations in vessels forming the Circle of Willis. In his observation of a large number of brains in the neuro-anatomy laboratories of the Jefferson Medical College, he shows that variations in the Circle of Willis are rather common, particularly the presence or absence of a small posterior communicating artery.

These variations are borne out in the brains of the cases in this series that died.

Lenormant,<sup>43</sup> collected forty-one cases of bilateral ligation of the carotid arteries (common and internal) with seven deaths, five due to cerebral disturbances. Cerebral disturbances when they occurred usually followed first ligation. It is absolutely necessary that a sufficient period of time should be allowed to elapse between the first and second ligation, so that a collateral circulation can be established. Lenormant reports two instances in the series where the operations were done at one seance, both died in coma, six in which the interval was less than a month, with two deaths and six others in which the interval was six to eight weeks, with one death while eighteen in which the interval was several months were all successful.

If we accept the embolic theory or the theory of cerebral softening due to impaired blood supply, we can possibly lessen the frequency of cerebral complications by care in exposing the artery, traumatising vessel as little as possible and using fascia, Halsted or Matas bands for ligation, thereby avoiding injury to the intima. Ligate carotid artery as far as possible from its bifurcation to avoid a large thrombus extending into internal carotid artery. If time permits as it would in the operation, we are discussing, the

anastomosis of the internal jugular vein to the common carotid artery, it would be possible to divide the operation into several stages, applying bands or strips of fascia lata for temporary ligation of artery to encourage collateral circulation.

Do the hydrodynamic laws fully explain the relief afforded these patients?

I have been impressed in doing this work with the immediate and lasting relief afforded the patients—this has struck me more forcibly in case No. III where there was a question raised as to the proper functioning of the anastomosis. This patient was bedridden for eight months, pain night and day—unable to move in bed without increase of pain. His relief was immediate when the carotid artery was cut across. It has been difficult to secure proper coöperation, in these cases, their answers are not definite; but I am satisfied that they are relieved. Improvement is shown immediately after operation.

The patient—Case III—as cited above, makes me consider another factor in the comfort the operation gives the patient and that is the severing of the sympathetic nerves supplying the artery.

The subsidence of pain following interruption of the sympathetic pathways is difficult to explain.

Experimental data has been advanced by Friedrich <sup>44</sup> in 1924, by Shilf and Stahl <sup>44</sup> in 1925 and Abrashanow <sup>44</sup> in 1927 to show that some sensory fibres supplying the arteries run longitudinally in the periarterial plexus. They demonstrated that pain can still be present when all the nerves supplying a vessel have been severed, but that when periarterial sympathectomy has been performed, pain ceases immediately.

While this theory may seem inadequate, nevertheless it cannot be ignored.

The interruption of the pathways along the common carotid artery also undoubtedly explains the absence of sweating on the side of the face corresponding to the side of the operation, inasmuch as it is an established fact that extirpation of the superior cervical sympathetic ganglion results in this, and as the carotid plexus is in continuity with the cervical ganglia the deduction is unavoidable.

*Technic of Operation.*—The patient is prepared before operation with preliminary injections of morphine sulphate and atropine.

The carotid artery selected for the anastomosis is to be to the distal side of the aneurysm. The skin, muscles and deep tissues are infiltrated thoroughly with 2 per cent. novocaine.

The head is turned away from the field of operation in order to bring a larger area into view. A transverse incision about 10 centimetres long is made 5 centimetres above the sterno-clavicular joint, the mid-point being on a line with the mid-point of the sterno-cleido-mastoid muscle on its posterior border or where a line erected perpendicularly from the middle of the clavicle would intersect the posterior border of the sterno-mastoid muscle.

The sterno-mastoid muscle is cut across, but in some cases it will not be necessary to cut both bellies, although complete severance of the sterno-mastoid muscle will give an unobstructed field to work in. The omohyoid

is next picked up and cut across, exposing the carotid sheath. The sheath is carefully separated for a distance of about 5 centimetres exerting great care not to injure the vessels or the vagus nerve. Both artery and vein are carefully separated and umbilical tape is applied to control the circulation in the vessels. The application of the tapes should follow the direction of the flow of blood in the artery and vein in order to facilitate natural drainage of the vessels and to prevent undue pressure distension in the vein.

To accomplish this the first tape is placed on the proximal end of the artery as deep in the neck towards the clavicle as is possible and the circulation carefully and slowly controlled. The second tape is placed on the artery near intended site of the anastomosis. The tapes are clamped with curved hemostats avoiding undue tightening so that the intima might not be injured. Two double heavy silk ligatures are then tied around the distal part of the artery, one above the other to prevent slipping, which may occur when the vessel retracts after cutting. Then two heavy silk ligatures are tied around the distal part of the vein.

The third tape is then applied to the proximal part of the vein in the same manner as applied to the artery.

The artery and vein are then cut across and the distal ends allowed to retract. The proximal ends, kept fresh with frequent douches of warm, normal salt solution, are then anastomosed (intima to intima) with vascular silk.

As to the actual method of anastomosing the surgeon may use any method of end to end closure preferred, but in this series the ordinary methods advocated for vascular suturing were found to be unsatisfactory due to diseased arteries.

Interrupted vertical mattress sutures were used on the medial wall of the vein and the lateral wall of the artery.

Interrupted mattress sutures were used on the medial wall of the artery and the lateral wall of the vein. This brought the intima of the artery in contact with the intima of the vein.

The vault of the anastomosis is then strengthened with continuous suture. The vein is usually redundant but the mattress sutures overcome this. After completion of suturing, the tape is removed slowly from the vein. The tapes controlling the artery are slowly loosened, but not removed at this time. There may be some bleeding from the anastomosis, which usually can be controlled by pressure and warm salt solution compresses. If bleeding is excessive additional sutures may be placed. After the anastomosis is perfectly dry and no seepage is observed, the tapes are slowly removed from the artery, occupying five minutes in the process, in order to prevent "racing" of the heart. The muscles are brought together with chromic catgut and the fascia and skin closed. No drainage is used.

In Case I, nitrous oxide and light ether were used, inasmuch as this was the first case. Local would be used now.

## ANEURYSMS THORACIC AORTA AND INNOMINATE

In Case VI the operation was begun under local anæsthesia, but displayed such marked nervousness that general anæsthesia was resorted to.

### CONCLUSIONS

1. Babcock's case has lived four years since the operation, which speaks well for the usefulness of the procedure. Of paramount importance has been the relief afforded him; economically—he has been able to return to work.

2. I consider the operation of arterio-venous anastomosis to be the operation of choice in aneurysm of the thoracic aorta and innominate artery.

3. Where, on account of the location of an aneurysm, the size or technical difficulties which beset an operation of direct attack on carotid, or subclavian arteries, this operation is to be considered.

4. The operation of distal ligation is to be relegated to oblivion. The danger of rupture of the sac following distal ligation is to be anticipated. Cures have been small in number.

5. Wiring has been useful in the treatment of certain forms of aneurysm, whether the operation of arterio-venous anastomosis will replace it future judgment will decide.

6. The relief afforded the patients as to pain, breathing and difficulty in swallowing justifies the operation of arterio-venous anastomosis.

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# SANGUINEOUS DISCHARGE FROM THE NIPPLE AND ITS SIGNIFICANCE IN RELATION TO CANCER OF THE BREAST\*

A STUDY BASED ON 108 CASES

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THERE are few clinical problems which present such wide divergence of opinion as the subject of the bleeding nipple. It is striking that a clinical problem of this nature is so far from possessing a common opinion. To many surgeons, a bleeding nipple immediately conveys the idea of cancer—with the necessity for radical mastectomy; while to others the condition means a benign tumor which is either locally excised or disregarded. Unfortunately the solution to the problem of the bleeding nipple is provided too commonly by a mastectomy—a procedure aimed to cover a lack of diagnostic ability on the part of the surgeon. We feel that in the majority of cases, it is possible to make a correct clinical interpretation of the physical signs presented and arrive at the exact pathological process or diagnosis. This is made more possible by the use of microscopical examinations of stained smears of nipple discharges and by transillumination. If one has successfully used these newer aids and correctly interpreted physical signs, then the problem of therapy becomes simple. After all, diagnosis is the *chief* issue.

The literature on the subject is replete with case reports of two to five such cases. The attempt to draw conclusions as to diagnosis and correct therapy is obviously forced from too few cases. On the other hand, there are some studies made on larger numbers of such cases by able observers, but since their opinions vary so markedly, it will require a number of studies dealing with large series to settle the question. Among our most experienced breast surgeons there is a definite contradiction of opinion. Cutler of our clinic in his recent paper on "Transillumination as an Aid in the Diagnosis of Breast Tumors" (Surgery, Gynecology and Obstetrics, June, 1929, pp. 721-729), briefly states the situation in saying that "many investigators favor the view that a hæmorrhagic discharge from the nipple of a nonlactating breast is evidence of a benign rather than of a malignant lesion and is almost a sign of intracanalicular papilloma (Bloodgood, Greenough and Simmons, Deaver and McFarland, Sistrunk). Miller and Lewis, on the other hand, found the same proportion of benign and malignant tumors, associated with this symptom, and Judd, in a review of 100 cases, reached a similar conclusion."

Our first reason for making this report is that the study is based on an unusually large series of cases presenting this syndrome. The second reason

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is that the weight of evidence herein presented will help to strengthen the contentions of those whose studies have shown that the benign and malignant tumors are about equally divided in frequency. The third reason is to emphasize the aid afforded by the microscopic study of the smear and the use of transillumination. The last two features are new and important in this field. No patient who has a sanguinous, serous or serosanguinous discharge from the nipple has had a complete preoperative study unless the smear examination and transillumination are included.

The 108 cases herein studied represent those which have come to the Breast Clinic of the Memorial Hospital\* during the past ten years. They include only those with serous, serosanguinous or sanguinous discharge from the nipple. No patient who has had a recent trauma is included in this study.

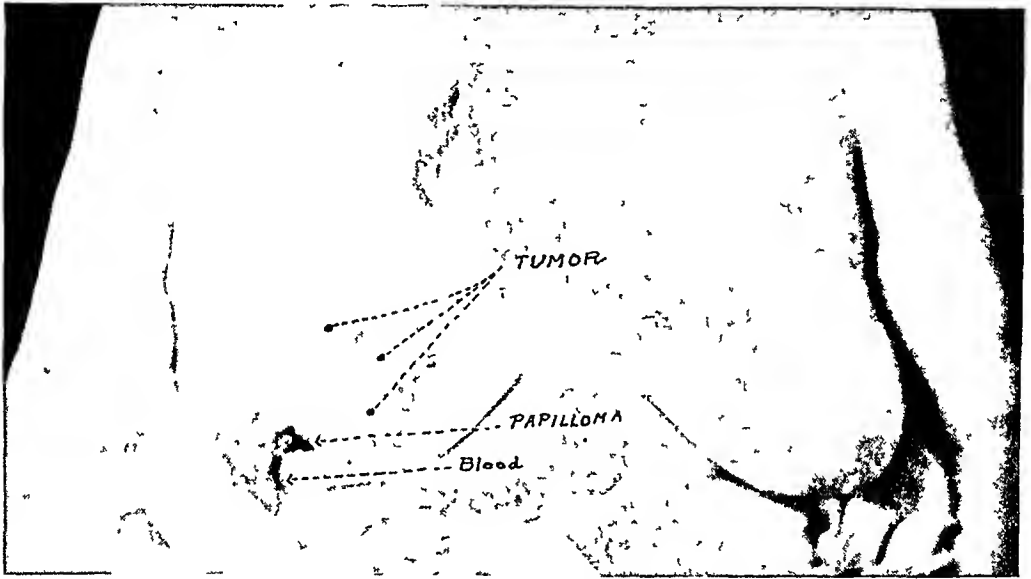


FIG 1—Shows the tumor situated above the nipple. A papilloma is presenting at the nipple surface from which blood flows continuously. Hemoglobin 40 per cent. Diagnosis, papilocyst adenocarcinoma.

No patient who has had childbirth or miscarriage within the past two years is included. This excludes many cases of discharge from the nipple offering a problem for solution; but these cases are usually easily diagnosed by a study of the smear. There are no inclusions in this report of Paget's disease, eczema of the nipple, ulcerations or infections. No discharge originating on the nipple surface can be properly included. In fact we feel that it is not proper to include those cases with the brownish, greenish and yellowish discharges unless the smear of this material shows an abundance of red blood cells, as these cases are usually chronic mastitis. We have made a careful effort to exclude these cases. Miller and Lewis (Journal of American Medical Association, November 17, 1923, p. 1651) state: "A thin serous or bloodstained discharge is regarded as indicative of an intracanalicular papilloma; a frank bloody discharge, of carcinoma; and a mucoid or dark

\* The author is indebted to Dr. Burton J. Lee, chief of the Breast Service, for the use of the material in this study.

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chocolate colored discharge of chronic mastitis." In general we agree with these observers; but as the chocolate, green and yellow discharges are indicative of chronic mastitis, and as the cancer problem could be easily settled by the smear, we see no reason for giving consideration in this report to such a discharge, as it is not a true serous, serosanguinous or hæmorrhagic discharge. The clinician must be sure that he is dealing with a bonafide case of bleeding from the nipple. If there is any question, this can be settled by microscopic examination of the smear. Many patients present themselves to the physician stating that they have had a bloody discharge from the nipple. In general a patient will interpret any colored discharge from the nipple no matter if brownish, greenish or yellowish as a bloody discharge. In fact, it was found necessary to exclude from this report, nearly 200 cases

of discharge from the nipple because they were not sanguinous, serosanguinous or bloody. In many instances the discharge in its gross appearance seemed to be serosanguinous, but on microscopic examination proved not to be; these smears contained pus cells, desquamated lining cells, cell detritus and crystals—such a smear being typical of the discharge found in chronic mastitis, but not

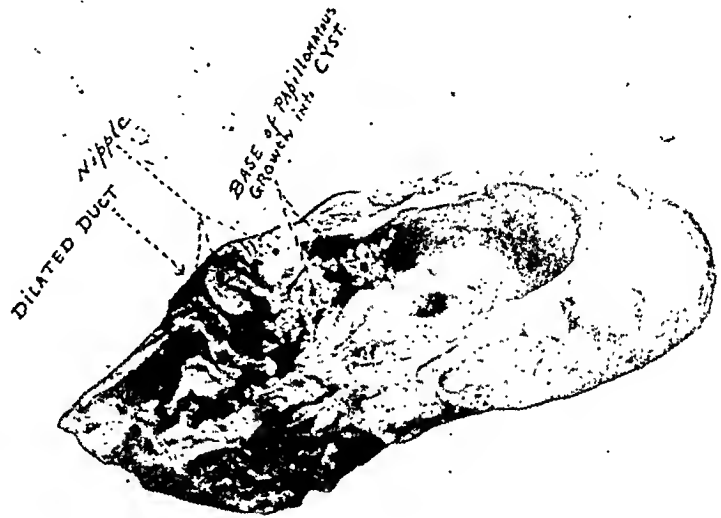


FIG. 2.—(Same case as Fig. 1.) Showing the dilated terminal duct through the nipple down which the papilloma descended. The smooth walled cyst was filled with serosanguinous fluid and with the shaggy papilloma. There is a connection of this cyst with a similar cyst containing similar elements.

found in cancer. By thus excluding those cases which do not have true serous, serosanguinous, or bloody discharge, the proportion of cancer cases of this report has been increased.

The transillumination test is one which is of very great value in localizing the lesion responsible for the bleeding into the mammary system. This test had as a basis, a suggestion made by Ewing who for a number of years has used as a rough laboratory test for carcinoma, the comparison of light permeation through normal and carcinomatous tissue. Ewing's technic is to cut a thin slice of the suspected tissue approximately one millimetre thick. On holding this tissue to the light (daylight or artificial) the light rays will not readily penetrate the dense hard carcinomatous tissue so that the area of carcinoma appears much darker than the surrounding normal tissues. Five years ago Ewing suggested that we attempt to utilize clinically a light permeation test. We attempted this experiment on a series of cases. A small electric light surrounded by thick rubber tubing was employed, but the light developed so much heat that it was not a practical thing to use. We did not then

know of any "cold" light such as was later employed by Cutler. However, before abandoning the test, one fact was definitely established even with this crude hot light; namely, that a lesion containing blood or surrounded by blood appeared black on being transilluminated. Such a thorough study of the different breast lesions as was subsequently made by Cutler with his cold Cameron light, was not possible. To the suggestion of Ewing and the persistence of Cutler, great credit is due for the development of this new diagnostic aid. The test has been freely employed in this series of cases and found to be of great value. Transillumination is important in studying *every* lesion which produces bloody discharge, but especially in those cases where there is more than one lesion to be palpated; and where the physician is in a quandary as to which one of the lesions is producing the bleeding. This test will clearly distinguish which lesion is to be extirpated unless it is one of those rare cases of papillomatosis in which case one sees the opaque outline of several lesions.

A study of the 108 cases shows the following:

TABLE I

	Cases	Percentage
Malignant neoplasms.....	51	47.2
Benign neoplasms.....	57	52.8
	108	100.

TABLE II

	Cases	Percentage
Papillary cyst adenoma or papilloma in a duct..	49	45.3
Carcinoma.....	48	44.4
Sarcoma.....	3	2.8
Chronic mastitis. . . . .	8	7.4
	108	100.

Table I shows that this series of 108 cases had approximately half malignant and half benign cases. This supports the contentions of Miller and Lewis and Judd. It differs with the studies of Bloodgood, Deaver and McFarland, Greenough and Simmons and Sistrunk. Such a percentage of malignant tumors in cases of bleeding nipple makes the problem of extreme importance. A physician, seeing a bonafide case of bleeding nipple, immediately must realize from this study that there is almost an equal chance that it may be a malignant tumor. It then follows that radical surgery should be employed in 47.2 per cent. of cases. On the other hand, 52.8 per cent. of bleeding nipple cases are cured by the employment of the simplest type of local removal of the tumor without sacrifice of the breast.

## SANGUINEOUS DISCHARGE FROM THE NIPPLE

Of the 108 patients studied, 90 or 83 per cent. were submitted to operation: eighteen cases were not.

*Papillary Cyst Adenoma.*—Of the forty-nine cases of papillary cyst adenoma or papilloma in a duct, forty cases were proven by operation and nine were not treated by surgery. Six of these nine cases had the characteristic tumor within or lying at the edge of the areola, which on pressure toward the nipple, expressed the bloody discharge at the nipple. If no tumor were palpable, the same pressure test, when applied to a particular point, caused this exudation of bloody discharge. This justified the inclusion of these nine cases under this heading, especially since they were young or middleaged women. The carcinomas occurred in women of higher age average than the papillary cyst adenomas and duct papilloma group.

The papillary cyst adenoma producing a serous, serosanguinous or sanguinous discharge at the nipple, is a definite clinical entity. Within the areola,



FIG. 3.—Gives the clinical appearance of a papillary cyst adenocarcinoma. There is marked retraction of the nipple. Shows the bulging of two cystic tumors which contain bloody fluid and a mass of papillomatous tissue.

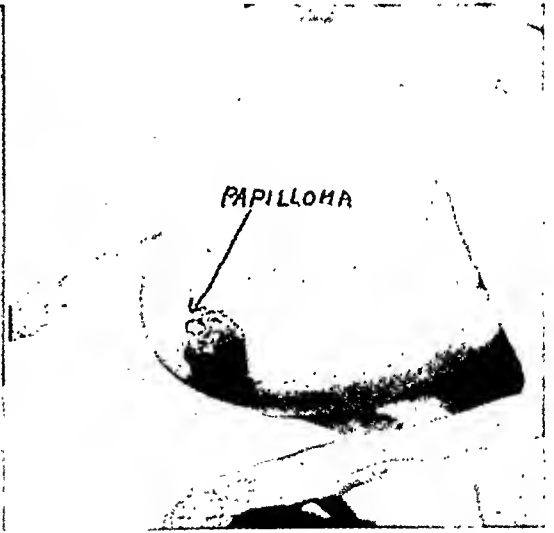


FIG. 4.—Showing fungation of the papillary cyst adenocarcinoma at the nipple. The papillary carcinoma has followed down the terminal duct to the nipple surface. There was continuous bleeding.

at the areolar edge, or behind the nipple, one finds a small tumor or localized thickening. If one presses on this tumor, a discharge at the nipple is produced which may at first be serous. The trauma of pressure may change the type of discharge to serosanguinous, then into bright red blood. The tint of the discharge depends on the amount of blood mixed with the serum in the small cyst; or how actively the blood is flowing from the open terminal capillaries of the fragile soft papilloma. The papilloma grows from the smooth wall of the ampulla into the lumen. It may continue to grow until it distends the ampulla forming a cyst. The papilloma frequently pushes along within the duct for some distance from its pedicle, and even at times appears through the orifice onto the nipple surface in which case there is continuous bleeding. The cyst with its contained papillomatous growth is called a papillary cyst adenoma. (See drawings of various types.)

The life history of this tumor is most interesting. Although it would

be impossible to prove the contention, my belief is, that the tumor remains localized for several years, at which time the papilloma commences to grow backward from its pedunculated attachment, penetrating the basement membrane. At the very point of beginning invasion of the surrounding tissues, a carcinoma is established and there is now a fully developed carcinoma called papillary cyst adenocarcinoma. (See Fig. 13.) This is the next stage beyond papillary cyst adenoma. In this series it took twelve and a half years on an average to develop from one lesion to the other if one uses as a basis of consideration the difference in age averages between the papillary cyst adenoma and the papillary cyst adenocarcinoma. It may be that there is a greater tendency for papillary adenomas to become cancers in the older women. The cancer cases give a longer history of bleeding than the papillary adenoma cases.

The above sequence in the life development of the tumor seems logical for the six following reasons:



FIG. 5.—The only case of bleeding nipple from chronic mastitis in a male. Diagnosis was established by operation. There was serosanguinous discharge at the nipple.

1. Papillary cyst adenoma occurs in young women as well as those in middle age; but it occurs rarely in the old subjects. The average age for patients with papillary cyst adenoma is forty-two years.

2. Papillary cyst adenocarcinoma occurs in patients of middle age and the older range of years. The average age is fifty-four and one-half years, averaging twelve and one-half years older than the

papillary cyst adenoma patients. There are six such cases in our series over seventy-five years of age while in the papillary adenoma group there are only six cases over fifty years of age.

3. Several sections show where this papillary adenoma is beginning to invade the basement membrane. (See Fig. 13.) Some have only begun to invade making it extremely difficult for the pathologist to classify as malignant or benign.

4. There are more papillary cyst adenomas than any other single lesion producing bloody discharge. If it be true that these lesions later go on to the carcinoma stage, one should expect there would be more papillary cyst adenocarcinomas than any other single type of carcinoma. This proves to be the case.

5. It seems logical that the benign papillary cyst adenoma should grow into the malignant papillary adenocarcinoma. Microscopic studies apparently support such a development.

6. Both lesions occur in the identical anatomical positions.

*The Duct Papilloma* is virtually the same type of lesion as the papillary

cyst adenoma. This lesion is composed of the three identical elements that compose the papillary cyst adenoma; namely, a papilloma attached to the duct wall, a dilated duct and blood free within the lumen. Case No. XLVIII (see Fig. 9) is a good example of the duct papilloma.

In the forty-nine cases of papillary cyst adenoma and duct papilloma, the discharge was serous, serosanguinous or bloody; and in but one instance was the blood stagnant and dark colored.

*Diagnosis* of papillary cyst adenoma and duct papilloma is based on four points:

1. The characteristic position of a tumor within or at edge of the areola.
2. The discharge is serous becoming serosanguinous or bloody by pressure or trauma over the tumor. This should be verified by a microscopic smear.
3. There is no nipple retraction, attachment to skin or other sign of cancer.
4. Transillumination test will show an opaque tumor *sharply* outlined.

*Treatment.* — Having accurately localized the papillary cyst adenoma or the thickening due to the presence of the duct papilloma, by both palpation and transillumination, the exact area is marked on the skin with an indelible pencil. The patient must be lying on the examining table as most tumors, especially the benign, shift

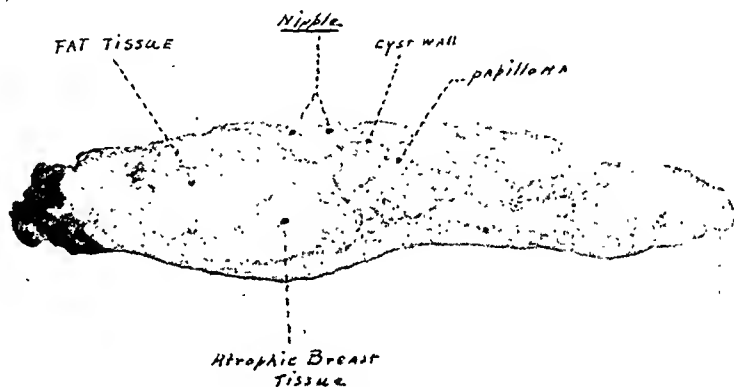


FIG. 6.—Shows the cyst almost completely filled with the papillomatous growth. Diagnosis papillary cyst adenoma. The breast tissue is much atrophied.

some distance from the position occupied in the breast when the patient is erect. Subsequent embarrassment of the surgeon at his inability to locate the lesion will thus be avoided by carefully marking the skin.

A radial incision under novocain anæsthesia is made, commencing near the nipple, going over the dome of the tumor to such a length as to be permitted to excise generously the tissue containing the offending lesion. It is particularly difficult at times to locate the lesion at operation.

Such a simple excision not only eradicates a source of annoyance to the patient, but it is performing important preventive cancer surgery. We believe many of these tumors eventually develop into cancer.

Since the establishment of a diagnosis is the first consideration, therapeutic irradiation has been infrequently employed because extirpation of the tumor immediately solved the problem of diagnosis. However, my belief is that radium employed interstitially would cure all cases of papillary cyst adenoma; and MANY of papillary adenocarcinoma if properly applied.

*Sarcoma.*—There were three sarcoma cases. In Case LXXXVIII the discharge was dark stagnant blood because the tumor lay at the periphery and the blood traversed a long distance before appearing at the nipple. In

Case IV the blood was thin and watery. The third case (Case VI) was in a male subject. In general, sarcomas disintegrate particularly in the centre of the tumor if there is much tumor bulk. This permits bleeding into the tumor. If located in the mammary system, the blood could easily find its way to the nipple surface.

*Chronic Mastitis.*—The eight cases of chronic mastitis showed no single papilloma into a cyst or duct, but in definite areas there was such hypertrophy of the lining cells that the proliferation was *comparable* to the papilloma. This could account for the serous and serosanguinous discharge. There was but one case of chronic mastitis which had a definite blood discharge. The blood exuded from one duct orifice and from two other orifices of the same nipple there was the typical discharge of chronic mastitis.

Ewing reported thirty-six of the forty-nine cases of carcinoma as having four pathologic types. In the fifth group of thirteen cases no slide was available for his examination.

TABLE III

	Cases	Percentage
1. Papillary adenocarcinoma.....	17	34.7
2. Duct carcinoma.....	12	24.5
3. Adenocarcinoma.....	5	10.
4. Infiltrating carcinoma.....	2	4.
5. Type unknown.....	13	26.5
	49	100.

The pathologic types of carcinoma are of great interest and clinical importance.

1. *Papillary Cyst Adenocarcinoma.*—The beginning of this lesion is described above under the heading of papillary cyst adenoma. We believe this carcinoma to be a later stage in the life history of papillary cyst adenoma. More cases in this report are of this type than any other. This was to be anticipated. Sixteen of the seventeen cases were operated on. This type is of comparatively low grade malignancy until late in the disease, when it takes on the characteristics of the more highly malignant types. Usually this type remains localized for several years before metastasizing to the axilla.

2. *Duct Carcinoma.*—This is the most interesting group of any type because our studies show that as a rule the dark stagnant bloody discharge belongs to this particular group and not to any other group of malignant or benign tumors. There is no previous mention in the literature on the subject pointing to the *type* of breast carcinoma which is responsible for this dark stagnant discharge. This sign is most helpful to the diagnostician. Nearly ten years ago we operated on a patient who had a very small lesion towards the periphery of the breast. The lesion was only 7 millimetres in diameter. There was dark bloody discharge at the nipple. On removal the

lesion proved to be a very early duct carcinoma (see Fig. 12). Soon afterward we encountered a similar case. We began to speculate on the type of carcinoma in such cases and found nearly all to have the same structure. There were twelve cases of duct carcinoma and with one exception (Case XXXIV) which was bloody but not dark blood, *all* duct carcinomas had this characteristic discharge. In more than one instance we have concluded that we were dealing with duct carcinoma because of the dark bloody discharge, and operation proved the assumption to be correct.

In *none* of the twelve cases of duct carcinoma was the tumor situated within the areola or at its edge.

From the above, one must *not* conclude that *every* case of duct carcinoma produces a dark bloody discharge. The majority of duct carcinomas produce no discharge at the nipple. But it is important to know that a case having dark bloody discharge at the nipple and having a tumor situated out in the breast substance away from the areola, will in most instances prove to be duct carcinoma.

### 3. *Adenocarcinoma.*—

There were five cases of adenocarcinoma. These cases probably should be included under the heading of papillary adenocarcinoma

because the pathologic processes and the developmental steps are so similar. Of the five cases, four were proven as having a sweat gland origin. They probably began as lesions of sweat glands which lay within the mammary organ, and having a definite connection with the mammary duct system. Ewing states that many sweat glands scattered through the breast have a direct connection with the mammary system and empty into it.

4. *Infiltrating Carcinoma.*—There were two such cases. We get no assistance from microscopic studies as to their histogenesis. The carcinoma had invaded the tissue so that the exact origin could not be determined.

5. *Type of Carcinoma Unknown.*—Of these thirteen cases, six were not subjected to operation. Seven were proven microscopically by other pathol-

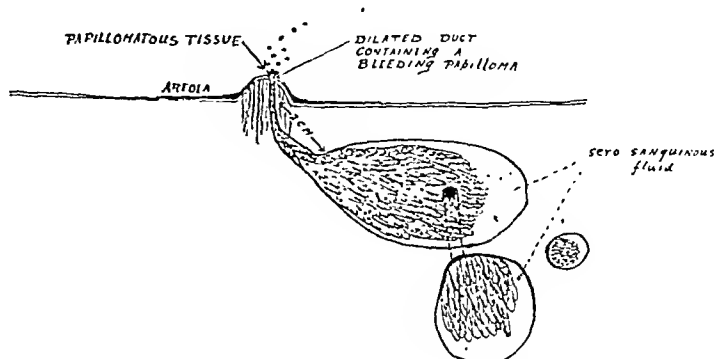


FIG. 7.—Same case as Figs. 1 and 2. Diagnosis papillary cyst adenocarcinoma. Drawing shows relative position of the growths as regards nipple and areola.

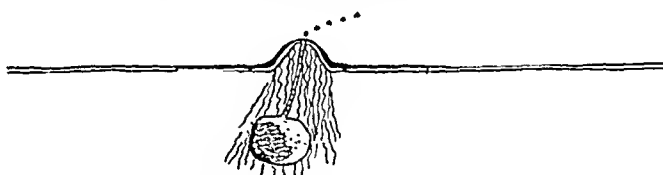


FIG. 8.—Shows a benign papillary cyst adenoma lying directly behind the nipple and having one widely dilated duct leading from the tumor to the nipple surface. Local excision; cured for seven years.

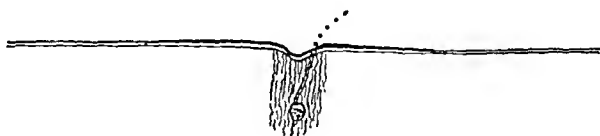


FIG. 9.—Lying behind the nipple which is inverted is a very small dilatation of a terminal duct. Into this projects a small papilloma. Diagnosis is papilloma of a duct or a very early papillary cyst adenoma.



ogists, but the slides were not available for us to study and determine the histogenesis. Of the six unoperated cases, the clinical signs and clinical course of the disease were such that there was no doubt of the diagnosis being cancer.

*Treatment* of these carcinoma cases is identical with that of any other case of carcinoma of the breast. To date, if the case is considered operable, the radical mastectomy is performed. When sufficient data is compiled on the irradiation therapy of operable breast cancer to compare with the results of operations, the probability is, that the radical mastectomy will be more carefully chosen than at present.

It is interesting that the papilloma descended the duct and appeared

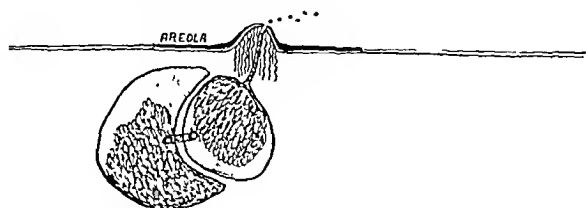


FIG. 10.—The papillary cyst adenocarcinoma. This type of tumor is more bulky than the papillary cyst adenoma. Lies behind the areola in its characteristic place.

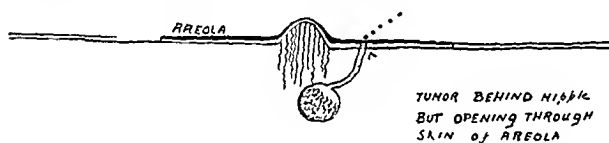


FIG. 11.—Showing an early papillary cyst adenocarcinoma. This is the only case of the series in which the bleeding did not take place through the nipple. There was a small orifice half-way between the nipple and areolar edge, through which blood exuded.

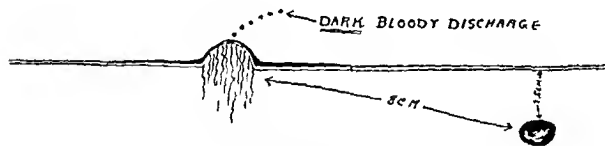


FIG. 12.—Showing the position of a beginning duct carcinoma. The tumor was 2.5 centimetres from the skin surface, situated 8 centimetres from the nipple. The discharge was dark stagnant blood at the nipple characteristic of duct carcinoma.

upon the nipple surface in six instances. These were in the cases of papillary cyst adenoma and papillary adenocarcinoma, particularly the latter.

Certain of the cases serve to illustrate interesting phases and problems arising in this disease. For example:

*Case I* (see Fig. I) was a papillary cyst adenocarcinoma. Constant bleeding from the projecting papilloma caused a profound *secondary anæmia*. The hæmoglobin was 40 per cent. and the patient very dyspnoic.

*Case LXXX* brings up the question of what the procedure should be in cases where no tumor is palpable. We think that in such a case the removal of the breast as is frequently practiced, is an un-

justified step. This type of case is treated with external irradiation by high voltage X-ray or radium packs. A watchful attitude is then assumed. The patient is observed at intervals. If a tumor develops, the patient is subjected to operation. In some instances the bleeding has ceased rather promptly by the external irradiation alone. In 50 per cent. of these cases so treated the bleeding has returned later, so that external irradiation handles the problem in only half of the cases.

In *Case LXXX*, blood was elicited by pressure upon the areola; but no specific area seemed to be the site responsible for the bleeding. Clinically it was impossible to determine at what site to operate if one desired to perform a local extirpation of the tumor. In this instance, a circular row or

gold seeds containing radium emanation was implanted half-way between the areolar edge and the nipple. The bleeding ceased immediately. This was in all probability a case of a very small papillary cyst adenoma or more probable a papilloma into a terminal duct. The radium placed interstitially destroyed either the lesion or the duct which emptied onto the surface. There has been no further growth of the lesion, and bleeding has never returned.

*Case LXXVIII* is of interest, as it brings up definite problems for speculation. At the age of thirty-five years, the patient was operated on by us for a bleeding nipple with the diagnosis of papillary cyst adenoma. This diagnosis was confirmed at operation. The lesion was removed. Bleeding ceased. The patient was kept under observation, being seen at intervals of three months. At the end of seven years she developed a carcinoma in this breast, infiltrating in type.

Was the carcinoma present at the time of the first operation? Did a carcinoma develop from another similar lesion which might have been present giving no symptoms? Did the carcinoma develop as an entirely different process than the benign tumor removed seven years previously? The case came under observation before the day of transillumination. This test might have detected a second lesion which did not announce itself by bleeding from the nipple.

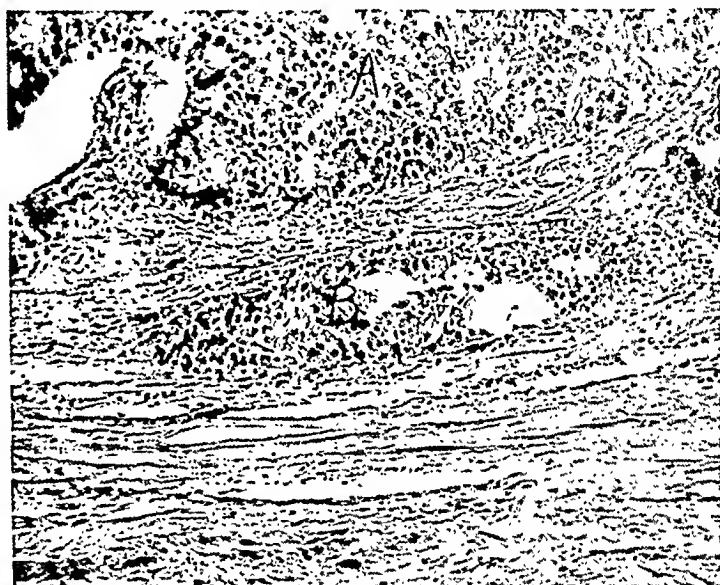


FIG. 13.—A. demonstrates the papillary carcinoma. B. shows a small area where the carcinoma is beginning to invade. Infiltrating adenocarcinoma.

In *Case XCVIII* the discharge was dark stagnant blood. On account of the nature of the discharge, we considered it to be a probable carcinoma even though no lesion was palpable. The value of transillumination was demonstrated in this case. By applying it, a small dark lesion was located out in the breast substance. The type of discharge together with a positive transillumination test justified an operation. The patient was operated on and a small lesion, the size of a split pea, was found. It proved to be a very early duct carcinoma.

*Case XXIX* also demonstrated the value of transillumination. Within the areola lay a small tumor, 7 millimetres in diameter. There was bleeding at the nipple. Pressure with the tip of the finger on the tumor produced increased nipple discharge. The diagnosis was papillary cyst adenoma. Under novocain the tumor was removed. It proved to be a butter cyst. The bleeding did not cease. Almost a year later transillumination of the breast was first successfully utilized. The test on being applied showed a

tiny dark area lying only 4 millimetres from the scar and almost a part of it. This was removed and the bleeding ceased immediately. The second lesion proved to be a papillary cyst adenoma which had been overlooked at the first operation. This case, in a striking way, demonstrated the value of transillumination.

*Case LXVII* is one which brings out another phase of transillumination. In this instance the transillumination test was positive but bilateral. Transillumination of the *left* breast revealed two opaque areas beneath the areola situated at five and seven o'clock from the nipple. They were about the size of small almonds. Pressure upon these caused excretion of sero-sanguinous discharge at the nipple. In the *right* breast there were also two opaque areas beneath the areola situated at three and nine o'clock. These evidently did not empty their blood into the secretory ducts.

*Diagnosis.*—Bilateral intraductal papillomatosis. No tumor was palpable in either breast. Bleeding at the nipple ceased by operating on the two tumors of the *left* areola which gave evidence of increased discharge by the pressure sign. This is the type of case on which Cheatle, of London, would remove both breasts as a preventive measure. His procedure may be correct, but in our clinic we find this type of case much more rarely than he finds it. Time only will tell whether or not we should be more radical in our method of handling this particular type of case.

Of the eighty-nine cases operated on, 95 per cent. were cured of the bleeding. Only 5 per cent. failed to have the bleeding stopped by the operation. These failures in all probability would not have occurred had the five cases been transilluminated and the lesion definitely localized.

*Etiology.*—We considered the possibility of external bacterial infection passing up the nipple ducts as having some bearing on etiology. A bacteriological study was made in a number of cases. The nipples and areolæ were sterilized by an application of 3½ per cent. iodine. Pressure was applied over the areola and a bacterial study made of the secretion obtained. The secretions were sterile. Bacteria seem to play no rôle in the etiology of these tumors.

The history of trauma has not been a prominent factor.

#### SUMMARY

1. There is wide divergence of opinion as to the significance of a serous, serosanguinous or bloody discharge from the nipple.

2. This study based on 108 cases of bleeding nipple demonstrates cancer in 47.2 per cent.; and a benign condition in 52.8 per cent. The syndrome of a bloody discharge from the nipple is therefore of great clinical importance.

3. Microscopic study of the smear from the discharge is of decided value particularly in excluding many cases which *appear* to have bloody discharge; but which on a microscopic study prove not to be bloody. Two hundred such cases were excluded from this report.

4. Transillumination of the breast is of great help in making a differential

## SANGUINEOUS DISCHARGE FROM THE NIPPLE

diagnosis and in *locating* the offending lesion. Bleeding tumors are opaque to transillumination.

5. The average age of patients with papillary cyst adenoma and papilloma of the duct is forty-two years; of papillary adenocarcinoma is fifty-four and one-half years.

6. There are more papillary adenomas in cysts than any other single lesion producing bleeding at the nipple.

7. Dark stagnant bloody discharge signifies duct carcinoma in most instances.

8. It is believed that the benign papillary cyst adenomas eventually develop into the papillary cyst adenocarcinomas.

9. *External* irradiation by two high voltage X-ray treatments or by one radium pack of 10,000 millicurie hours stopped the bleeding in 50 per cent. of the cases. However, bleeding ceased temporarily. It is admitted that radiation was not adequately pursued to draw ultimate conclusions concerning cure.

10. In six instances the papilloma descended the nipple duct, appeared at the nipple surface and produced continuous external bleeding. In one case the secondary anemia was profound, the hæmoglobin being 40 per cent.

11. Bacteriological studies of the discharge were negative, ruling out a bacterial origin of etiology.

12. Of the eighty-nine cases operated on, bleeding ceased in 95 per cent.

13. Fifty-two per cent. of bleeding nipple cases are cured by the simplest type of surgery. We consider this extirpation as important preventive cancer surgery.

## PHRENIC NERVE SURGERY\*

BY CARL R. STEINKE, M.D.

OF AKRON, OHIO

THE phrenic nerve is the main motor nerve to the diaphragm, but also carries a few sensory fibres. One group of students believes the phrenic nerve is the only motor nerve to the diaphragm, while another group contends there are other motor nerve supplies to the diaphragm from the lower intercostals.

The phrenic nerve arises mainly from the fourth cervical nerve with additional fibres coming from the third and fifth cervical nerves. It passes down the neck crossing the scalenus anticus muscle from without inward and accompanies this muscle between the subclavian artery and vein, where it enters the thorax. The left nerve is about  $1/7$  longer than the right due to the position of the heart and the height of the diaphragm on this side. There are two main sets of branches, those to the pleura and those to the pericardium, while near the diaphragm the nerve divides into its terminal ends. In about twenty per cent. of cases there is an accessory nerve from the fifth, or fifth and sixth cervical nerves which joins the phrenic in the thorax. Anomalies of the nerve and accessory trunks are very common. There may be one or several trunks of the main nerve which complicates the operation.

The diaphragm has three major functions: (1) Anatomically it forms a partition between the thorax and the abdomen; (2) It is a great factor in respiratory movement; (3) When contracted it aids the abdominal muscles in the extrusion of feces, urine and offspring. Severing or evulsion of the phrenic nerve on one side does not interfere seriously with the functions of the diaphragm, although some patients experience difficulty in evacuating the bowels for a time following phrenicectomy. The abdominal cavity being a compartment with all sides relying mostly upon muscles for its major support can adjust itself to the loss of contractility of certain of these muscles; therefore accommodation for paralysis of one side of the diaphragm is soon developed.

The conditions for which phrenic nerve surgery may be indicated are: (1) Preliminary to operation for diaphragmatic hernia. (2) Preliminary to drainage of subdiaphragmatic or liver abscess. (3) Preliminary to thoracoplasty. (4) For bronchiectasis, especially when unilateral. (5) Persistent or uncontrollable hiccough. (6) Diaphragmatic tetanus. (7) Tumors involving the diaphragm either on the thoracic or abdominal side. (8) Pleural adhesions to the diaphragm causing pain or disability. (9) Pulmonary gangrene. (10) Lung abscess uncontrolled by other measures. (11) Pulmonary tuberculosis in various phases.

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\* Read before the Association of Resident and Ex-Resident Physicians of the Mayo Clinic and Mayo Foundation, October 8, 1929.

Types of nerve operations: (1) The simplest procedure is the stretching of the nerve. This is sometimes done for persistent or uncontrollable singultus. If traction on one or both nerves checks the hiccup, but it soon recurs, a heavy silk or linen suture may be passed around the nerve and the two ends brought outside the incision for repeated traction to control the diaphragmatic spasm. (2) Crushing of the nerve and its accessory is the next procedure in the scale of radicalness. When traction on the nerves fails to relieve singultus then they should be crushed. It is employed for diaphragmatic tetanus and any condition where temporary paralysis of the diaphragm is desired. It may be used preliminary to operations for diaphragmatic hernia,

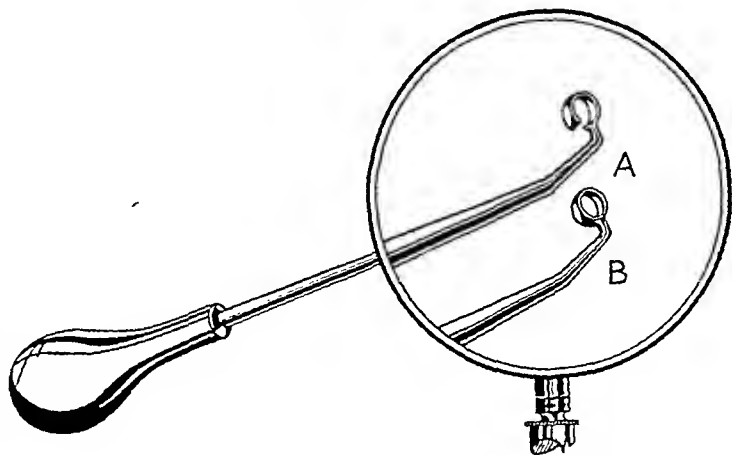


FIG. 1.—Phrenic Nerve Stripper. (A) Open tip. (B) Closed tip.

lung abscess, subdiaphragmatic abscess or liver abscess. The time of functional return to the diaphragm after crushing of the nerve is said to be from three to eight months, but generally from five to six months. (3) Phrenicotomy is the cutting of the nerve together with its accessory. This procedure is used for pleural adhesions to the diaphragm, diaphragmatic hernia, bronchiectasis, thoracic tumor involving the diaphragm, preliminary to thora-

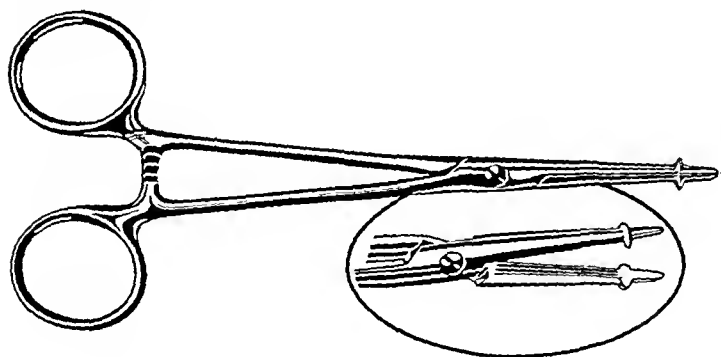


FIG. 2.—Modified Proctor Phrenic Nerve Evulsor.

coplasty, for lung abscess, and various stages of pulmonary tuberculosis limited mostly to one side (especially cavity formation, pleural adhesions preventing pneumothorax, certain apical and basal lesions and recurrent hemoptysis). (4) Phren-

icectomy, exeresis or evulsion is the complete removal of the nerve and the tearing off of the accessory trunk or the removal of a good portion of the nerve and the accessory branches. It is used for practically the same conditions as phrenicotomy.

At times it is difficult to locate the accessory branch or branches. To assure complete separation or severance of these branches I have devised a nerve stripper in two types. (Fig. 1). After crushing the nerve the instrument with an opening in the loop through which the nerve proper passes is carefully pushed down the course of the nerve beyond the junction of the accessory branches tearing off the latter. In phrenicotomy and phrenicectomy the

Name	Sex	Age	Stage	Side Opened	Rise of Dia- phragm in C. M.	Sputum		Temper- ature		Pain		Hæmor- rhage		Result of Operation	Final Result	Later	Complications
						Be- fore	Af- ter	Be- fore	Af- ter	Be- fore	Af- ter	Be- fore	Af- ter				
Blanc	F	28	III	R	3	+++	-	+	-	+	-	-	-	Good	App arrest	Thoracoplasty	Trouble in defecation—6 wks.
Boyde	F	26	III	L	4	++	-	+	-	+	-	-	-	Good	Improved		
Bukavale	F	27	III	L	6	+	-	+	+	+	-	+	+	Excellent	Arrested		
Cresco	F	21	III	L	2	+++	+	+	+	+	-	-	-	Excellent	Arrested		
Cook	F	37	III	L	6	+++	+	+	+	+	-	-	-	Fair		Thoracoplasty	Fullness and gas in stomach Loss of voice for two weeks
Crane	F	33	III	L	3	++	+	+	+	+	-	-	-	Fair	Arrested		
Davis	M	39	III	L	2	++	+	+	+	+	-	-	-	Excellent	Died		
Dudley	F	36	II	L	6	+++	+	+	+	+	-	-	-	Good	Quiescent		
Ellum	F	16	III	L	3	+++	+	+	+	+	-	-	-	Fair	Still active	Thoracoplasty Advised thorac.* Thoracoplasty	Complete loss voice 6 wks. partial 3 mos. Thoracic duct injury
Fullum	M	50	III	L	3	+	+	+	+	+	-	-	-	Minimum	Still active		
Green	M	35	III	L	3	+++	+	+	+	+	-	-	-	Fair	Arrested		
Hanna	F	36	III	L	3	+++	+	+	+	+	-	-	-	Good	Arrested		
Kratits	F	30	III	L	6	+++	-	+	+	+	-	-	-	Good		Thoracoplasty	Loss voice 4 mos.—still hoarse Partial loss of voice—later hoarse
Narasoa	F	21	III	L	2	+++	+	+	+	+	-	-	-	Fair			
Moran	F	30	III	L	2	+++	+	+	+	+	-	-	-	Fair			
Paul	M	35	III	L	2	+++	+	+	+	+	-	-	-	Good	Quiescent		
Pfeiffer	M	27	III	L	3	++	+	+	+	+	-	-	-	Excellent	Quiescent	Thoracoplasty	Trouble with defecation, gas, pain, fullness
Pekard	F	25	II	L	6	++	-	+	+	+	-	-	-	Excellent	Quiescent		
Richards	F	23	III	L	5	+++	+	+	+	+	-	-	-	Good	Chronic; cavity		
Simons	F	24	III	L	3	+++	+	+	+	+	-	-	-	Good	Chronic; cavity		
Schilling	F	20	III	L	4	+++	+	+	+	+	-	-	-	Fair	Quiescent	Thoracoplasty Advised thorac.* Advised thorac.*	Ischio rectal abscess
Streblor	F	20	III	R	6	+++	+	+	+	+	-	-	-	Excellent	Quiescent		
Tate	F	35	III	L	2	+++	+	+	+	+	-	-	-	Fair	Chronic; cavity		
Whitnight	M	52	III	L	2	+++	+	+	+	+	-	-	-	Fair	Chronic; cavity		
Williamson	F	22	III	L	5	+++	-	+	+	+	-	-	-	Excellent	Quiescent	Thoracoplasty Advised thorac.* Advised thorac.*	Chronic empyema bronchial fistula
Teel	F	34	Empy- ema	L	2	+++	-	+	+	+	-	-	-	Good	Died of pneu- monia		
Lane	F	48	II	R	3	+	-	+	+	+	-	-	-	Good	Quiescent		
Pittman	M	45	III	R	2	++	+	+	+	+	-	-	-	Fair	Chronic; cavity		
Friddle	F	37	III	R	5	+++	+	+	+	+	-	-	-	Fair	Quiescent	Thoracoplasty* Pleural adhesions	Chronic empyema bronchial fistula
Jones	F	29	III	L	5	+++	+	+	+	+	-	-	-	Fair	Quiescent		
Warren	M	49	III	R	3	+++	+	+	+	+	-	-	-	Good	Quiescent		
Cannon	M	29	III	L	3	+++	+	+	+	+	-	-	-	Fair	Improved		
Richards	F	31	III	L	7	+	-	+	+	+	-	-	-	Good	Quiescent	Thoracoplasty* Pleural adhesions	Chronic empyema bronchial fistula
Richards	F	23	III	L	?	?	-	+	+	+	-	-	-	Too early	Died later		
Lawson	M	28	No T. B.	L	?	-	-	+	+	+	-	-	-	Fair	Quiescent		
Brewer	M	45	No T. B.	R	3	-	-	-	-	++	+	-	-	Good	Excellent		

\* Thorac—Thoracoplasty. I am indebted to Drs. C. L. Hyde and Theodore Herwing for the privilege of operating upon these cases.

## PHRENIC NERVE SURGERY

distal end of the severed nerve is threaded through the closed loop of the instrument and the stripper cautiously pushed down to tear off the accessory nerve. The nerve proper is adherent to the pleura and lung in some cases so that it cannot be evulsed but tears off above the accessory branch. The stripper is used to free the nerve from these adhesions and one can be assured of getting out most of the nerve by this procedure. To evulse the nerve it is rolled very slowly over a hemostat, preferably a special Proctor forceps or its modification. (Fig. 2).

The technic of phrenicectomy will not be considered at this time, as it has been described in various articles and unusually well by John Alexander.†

Complications that may take place in phrenic nerve surgery are: Injury to the vagus, long thoracic, brachial plexus or sympathetic nerves; the thoracic duct, pleura or large vessels. The voice has been affected for varying periods of time, but usually recovers. Difficulty in evacuating the bowels has been observed, but gradually adjusts itself.

The results of thirty-five phrenicectomies are shown in the table.

### SUMMARY

1. Phrenic nerve surgery is safe in trained hands.
2. It should be used earlier for the conditions indicated.
3. Phrenicotomy and exeresis should be performed more often and earlier when pulmonary tuberculosis is limited mostly to one side. These operations will not supplant pneumothorax, but should be used more often in conjunction with pneumothorax when the latter causes distress, has to be repeated too frequently or under fair trial does not effect the desired result.

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† Surgery, Gynecology and Obstetrics, vol. xlix., No. 3, p. 372, September, 1929.



# ŒSOPHAGEAL OBSTRUCTION\*

CAUSES, DIAGNOSIS AND SURGICAL TREATMENT

BY NATHAN W. GREEN, M.D.

OF NEW YORK, N.Y.

THE usual disorders of the œsophagus are accompanied by more or less definite symptoms of disorders of deglutition. These symptoms are of an intermittent nature, or of a permanent nature or of an intermittent nature gradually becoming permanent. They are accompanied by pain or distress or they come on insidiously. There may be hæmorrhage from the œsophagus; this is comparatively rare.

The causes of obstruction may be physical or of a nervous origin. Physical causes are benign strictures or diverticula, congenital malformations,<sup>1</sup> varices, polypi, extrinsic pressure, tuberculosis, foreign bodies or malignant diseases in the œsophagus itself (Abel).<sup>2</sup> Malignant disease in the cardiac end of the stomach causes obstruction both spasmodic and organic (Einhorn).<sup>3</sup> The neurotic causes are spasm causing a contraction of the lower end of the œsophagus or of the introitus or may be due to disorder of the mechanism of deglutition caused by bulbar palsy (Heyrovsky).<sup>4</sup>

Benign stenoses of the œsophagus are due to contraction of the lumen after burns with acid or caustic alkalies, foreign bodies, post-diphtheritic cicatrization and ulceration from other causes, perforation with abscess, peri-œsophageal inflammation and congenital defects.

Diverticula of the œsophagus generally occur at the upper end arising at the level of the cricoid and by compression are enlarged until filling with food they act as a partial obstruction. They may occur lower down by traction from some outside cause, such as cicatrization following a suppurating mediastinal gland (Vimtrop).<sup>5</sup> Rarely diverticula occur in the lower third (Smith).<sup>6, 7</sup>

In my experience by far the most frequent cause of œsophageal obstruction is new growth. This occurs generally about middle life. But cases have been seen to occur as early as in the third decade. The usual site is at the level of the bifurcation of the trachea or at the epicardia. More rarely at the upper entrance of the œsophagus. The usual type of growth is that of a squamous epithelioma but a few cells of a basal nature may be found in the lower end of the œsophagus and these may give rise to the basal cell type. (I believe however when a biopsy reveals this type the lesion has ascended from the stomach.)

Œsophageal spasm, generally called cardiospasm, has occurred in my experience less frequently in men than in women. One is unable to say just what is the causative factor. Among my cases I have noted the presence of

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\* Read before the New York Surgical Society, November 27, 1929.

gall-stones. This also has been the experience of Einhorn. Extreme viceroptosis is also sometimes present. In a conversation with Rovsing, of Copenhagen, he also noted the presence of gastropptosis. Frequently the cardiospasm occurs in a person of apparently neurotic habit. Whether the spasm is due partly to the nervous condition or whether the nervous condition is superinduced by the factors which also cause the cardiospasm remains to be determined. I do believe however that some reflex irritation has much to do with its causation.

All obstructions of the œsophagus may be roughly divided into benign and malignant. All of the benign can be successfully treated by surgery in one form or another. Of the malignant diseases, those of the middle and lower third have given some hope of cure by radical surgery. Less has been noted of malignancy occurring in the upper third. For many years radical surgery met with immediate failure. If one looks up the literature, for many years this was also the case with the now simple procedure of gastrostomy (Quick and Martin).<sup>8</sup> Now at the present writing there are a few cases on record in which a radical exenteration has been performed and the patient has recovered.<sup>9, 10</sup> (Eggers' cases: first case, one and one-half years and the other case, seven and one-half months), (Torek's case, which lived for twelve years). Others have recovered from operative procedure but have died some months later (Lilienthal).<sup>11</sup> Hedblom had a successful case of resection of the cardia.<sup>12</sup> In 1924 Willy Meyer stated that the literature of the world recorded six cases that had recovered after resection of the cardia.<sup>12a</sup>

The reason why both malignant and benign strictures occur more frequently in the lower part of the œsophagus has been explained by the fact that in the act of deglutition the bolus descends rapidly to a point near the juncture of the middle and lower third and from there on it proceeds more slowly. This has been confirmed by LeWald<sup>12b</sup> in the fluoroscope. One may see from this that the hot bolus proceeds slowly from the juncture of the middle and lower third throughout the extent of the lower third and it is possible that repeated irritation may in part be conducive to the development of epitheliomata here. The same holds good in regard to caustic alkalies and acids causing stenoses.

*Benign Stricture of the Œsophagus.*—This occurs frequently in young children from the swallowing of some caustic alkali as forcibly pointed out by Chevalier Jackson.<sup>13</sup> Acid burns are more rare and may occur in adults either from a self-destructive motive or when taken in mistake. Stricture following diphtheria has also been noted.

Other benign causes of obstruction are foreign bodies and diverticula. Diverticula of the œsophagus generally occur as before mentioned at the level of the cricoid and become progressively larger by continued development. It is believed that the inception is due to some weakness in the musculature of the œsophagus allowing the mucous membrane to pouch through it. Those occurring nearer the middle of the œsophagus are probably due to suppuration of one or more mediastinal glands rupturing into the

œsophagus or to some injury from swallowing a traumatizing object. Diverticula occurring in the lower third are rare and the cause is undoubtedly due to some congenital defect.

The main point in all diseases of the œsophagus is to make the diagnosis early and to give treatment which will overcome the condition. Dysphagia may be intermittent as in diverticula and cardiospasm or may be constant and progressive as in benign strictures and malignant disease.

The picture of benign obstruction differs from that of malignant obstruction in the history, and frequently the age and general condition of the patient. The sense of weakness is not so marked in benign conditions unless they have progressed far. In malignant conditions one is more likely to find weakness and pain and a more permanent apprehension in the patient's mind.

*The Means for Diagnosis.*—The diagnosis is made by the history, by the general appearance, by the symptoms, by the fluoroscope and röntgenogram, by the delicately passed bougie and by direct inspection. In passing a bougie the most extreme delicacy of touch must be employed; then frequently the experienced hand can gain an inkling of the condition present. This is especially valuable when differentiating between cardiospasm and new growth of the cardiac end of the stomach causing obstruction. Some writers are opposed to passing a bougie without the aid of vision, but this must be left to the personal equation of the operator. A most delicate touch is required.

*The General Differential Symptoms.*—*In malignancy; in benign cases:* Cicatricial stricture, Foreign Body, Diverticulum, Cardiospasm.

In *malignancy* the average age is greater. Seldom do cases appear before the age of thirty years. The disease comes on insidiously; seldom is there pain in the early cases. Often a "curious abnormal sensation in the thorax which may or may not be related to swallowing" is an early symptom. Or the first suspicion the patient may have of trouble is the sticking in the gullet of some solid substance. This passes off and for a time fears are allayed until it recurs with shorter interval. Then the patient selects his diet to exclude more solid food and toward the time the surgeon sees him he is only swallowing cream soups and fluids. Torek calls this the third stage.

In *cicatricial strictures* the average age is much younger. Generally the victims of accident are children. The cause of the trouble is flashed upon the field of diagnosis by the history of swallowing some caustic substance generally containing lye. In adults the caustic may be acid or alkali taken in mistake or with self-destructive intent. The ulceration is extensive and immediate and a peri-œsophagitis is a concomitant. At the end of a few days obstruction is manifest and progressive, and starvation stands at hand.

In the case of a *foreign body* there is the history of swallowing it. This is generally elicited even in the case of young children. The body may lodge at the entrance of the gullet or at the lower end, *e.g.*, the epicardia. If at the upper end there may be some change in the voice. If at the lower end, only obstruction to solids. It is the inferior cervical region of the œsophagus

just above the sternal notch which is the most common site of impaction of foreign bodies.

*Diverticulum.*—Here the age is adult, the difficulty in swallowing intermittent. The patient is able to press out retained food if in the neck. In rare cases of pulsion diverticulum in the lower third there has been reported a concomitant cardiospasm with the features of this overshadowing. (M. K. Smith's case.) (M. Goldstein.<sup>14</sup>)

*Cardiospasm.*—In this condition age plays some rôle but only after puberty. I have not seen a case under twelve years. The patient generally looks healthy, has nervous energy and may or may not be emaciated, according to the duration, severity and persistency of the spasm. There is a feeling of a "lump in the throat," a fulness in the lower mid chest and a feeling of weight under the sternum. This may at times be relieved by an upward stretching of the neck and bending of the body backward. The history of a mental shock and of domestic worry is frequently brought out.

*The Differential Findings.*—In differentiating obstruction due to benign conditions from malignancy, one has to differentiate also between various kinds of benign conditions. In all obstructions of the œsophagus it is advisable first to have a röntgenogram (Sgalitzer recommends the horizontal position).<sup>15</sup> By means of a skiagram one has a strong hint of the trouble. After this, passing the œsophagoscope can be done with greater facility and more safety.

In malignant diseases of the œsophagus, epithelioma of the squamous type is the most frequent. This generally presents in the picture a ragged shadow, whereas in strictures due to cicatricial tissue, the shadow is more clearly defined and the gullet above is cup-shaped with definite convexity of its outline downward. A minor point in technic which I have used with success is to attach a narrow strip of adhesive plaster longitudinally from tip to hilt of a medium-sized olivary bougie. If the obstruction is due to malignancy and has a raw surface, on passing and withdrawing this bougie, so decorated, the white strip will come back tinged with blood. This is a simple procedure and is not difficult for the surgeon nor for the patient. Here again of course great delicacy and no force must be used in passing it.

Œsophageal obstruction due to paralysis is usually concomitant with some paralytic manifestation in the tongue and lips (glosso-labio-pharyngeal paralysis). (In one case of mine confirmed by a competent neurologist, and upon whom previous to falling into my hands a gastrostomy had been performed for the relief of the starvation, the œsophagoscopic picture was that of an atrophic mucous membrane with wrinkles running at right angles to the long axis of the gullet.)

In cardiospasm there is the röntgenological picture of a dilated œsophagus with a blunt funnel terminating in a sharp constriction at the cardia, the amount of œsophageal dilatation depending on the persistency and duration of the dysphagia.

*The Œsophagoscopic Picture.*—In malignancy the cardia is not seen to

open and shut on respiration; the œsophagus is not so much dilated; there is no orderly arrangement of the folds right above the stricture. The mucous membrane above the site of the ulceration appears œdematous. There is a granular ulcerated area which bleeds easily and which is unmistakable.

In *benign stricture*, as it has most frequently come to me, there is less tendency to bleed. The mucous membrane above the stricture is not œdematous. The upper lumen of the stricture is clearly visible. There may be one or more strictures of large calibre through which the endoscope can pass before it comes upon the tight constricting lumen of the obstructed region. Guisez maintains that they are usually multiple. There is usually absence of the granulating area so commonly seen in epitheliomata.

In *foreign bodies* the picture is not as simple as it might seem. If the object is lodged at the upper introitus, the instrument may first pass by it and nothing but the normal mucous membrane be seen. Then it must be withdrawn and re-inserted with visual direction, and if the body be a safety pin or a coin or metal object with a bright appearance, a metal flash may be all that is seen as it presents its edge or its shank to the forceps. If the object is lodged in the lower third it is easier to see and determine its nature.

In a *diverticulum* one expects to find normal mucous membrane. If the patient swallows a black thread it may go down the œsophagus—not always. This may then be followed down and the opening of the neck of the sac seen in passing. Without this the opening may be passed without discovery. But the œsophagoscope is a valuable aid when it passes into the neck of the sac. In such an event it can be passed in farther and soon one finds the limit. It can then be withdrawn and passed on down the gullet past the opening.

The *normal œsophagus* opens and closes with the act of respiration. The cardia takes part in this procedure.

In *spasm* the cardia remains closed and the œsophagus above it is somewhat dilated and due to the delayed presence of food develops a thickened mucous membrane; the œsophagus is paler. There is also no bleeding. There are folds in the œsophagus which run into the sphincter giving a stellate picture in the field of the œsophagoscope.

*Treatment of Malignant Cases.*—The treatment of malignant cases may be either radical or palliative. The radical treatment although fraught with high mortality has been successfully carried out in repeated instances (Torek, Eggers, Lilienthal and Hedblom). The successful surgical accomplishment of a thoracic resection of an œsophageal cancer represents as brilliant a feat as any in feasible surgery. For the details of the operation and the steps which led up to its final successful outcome and to the pioneer work which paved the way, I must refer you to published reports of these cases and of the work preceding them. (Torek, Eggers, Lilienthal, Hedblom and Meyer.)

Gorbrandt<sup>16</sup> gives preference to the intra-abdominal rout, drawing down the cardia. Only those tumors which are situated in the lower third can

be operated upon in this way. Denk (Vienna) reports two cases thus operated upon with a successful outcome.

Fischer<sup>17</sup> has proposed a very ingenious operation for implantation of the œsophagus into the stomach after intra-thoracic resection for carcinoma.

Based on the researches of Sauerbruch, Willy Meyer, Lilienthal, H. H. Janeway<sup>18</sup> and many others both in the laboratory, at the bedside and in the thoracic cabinet, aside from the necessary shock incident upon so severe and unusual a procedure, the question of infection is most important. Ingenious attempts have been made to overcome this menace by some form of drainage. One of these is the closed method described by J. H. Kenyon and advocated strongly by Willy Meyer, who also advocated a potential drainage which could be made active two or three days after the operation should an accumulation of fluid occur.

A very significant and important point in Torek's operation for resection of œsophageal growth is the complete exenteration of the œsophagus from the mediastinum bringing it out through an opening at the base of the neck upon the chest. For no matter how carefully nor how firmly the proximal stump of the œsophagus is sutured within the thoracic cavity, opening the œsophagus within the mediastinum jeopardizes asepsis and, furthermore, the unavoidable attempt at swallowing will eventually cause sutures to give way. In my opinion this exenteration of the œsophagus in its entirety from the chest is a major point in the success of the procedure.

*Palliative Treatment.*—The palliative treatment consists in an attempt to prolong life and to decrease the discomfort of the patient. If obstruction is severe when the patient is first seen, provided the patient has still sufficient vitality to resist an operative procedure, a gastrostomy is advisable. This is done under local anæsthesia or under general anæsthesia if further exploration is desired. The varieties of gastrostomy are of the Stamm-Kader type, the Witzel type and the Janeway type. The Stamm-Kader type is very easy to do and does not place much tax upon the patient. The objection to the Stamm-Kader and the Witzel type is that occasionally the tube by accident is pulled out before the tenth day. It is then very hard to reintroduce it. Fatal accidents have occurred because of this. The advantage of the Janeway type, although making a slightly larger operation is a continuous mucous tube from the stomach to the skin which will not easily grow together and which may be controlled by pressure. Furthermore, if by chance the tube should be pulled out before the tenth day, it is easy to find the mucosa pouting out upon the skin and reintroduce the tube. As it becomes well healed the tube may be removed and only reinserted for feeding. Supplementing the gastrostomy, X-ray or radium treatment or a combination of the two has been given.<sup>19</sup>

The palliative treatment may prolong life for a short time. Exceptional cases have been noted of a year or even years, but it is conceded by all that cases so treated are doomed to mortality within a relatively short time.

*Treatment of Cicatricial Stenosis.*—The treatment of stenosis following

the swallowing of caustics, if the case is presented early, should be by a washing out of the œsophagus with a small rubber tube<sup>20</sup> and the gentle passage of flexible bougies or catheters.<sup>21, 22</sup> If the case comes later, some form of dilatation by means of direct vision through an œsophagoscope should be attempted, provided a filiform bougie can be passed into the stomach. This may be followed by a dilating bougie threaded upon it, as is the custom in genito-urinary surgery. When the dilatation of the stricture or strictures, for many times they are multiple (Guisez)<sup>23</sup> and of varying degrees, has proceeded sufficiently a Lerche's glove stretcher dilator may be introduced through the œsophagoscope and the stricture dilated progressively from above downward. This requires repeated sittings. If the patient comes in an emaciated condition with a long history of stenosis, a gastrostomy should be performed. This is preferably of the infolding type, which after it has served its purpose, both for feeding and for the passage of a string to be used in the string-sawing method of Abbe,<sup>24</sup> may be allowed to close spontaneously. The string-sawing method of Abbe I have used successfully in a number of cases and where it can be performed, it is a most satisfactory means of dilatation for tight cicatricial strictures. I have never witnessed any unfavorable result from it. On the other hand if the strictures are tight and extensive and one cannot make sure of passing into the stomach a string or a filiform bougie, and a retrograde catheterization cannot be accomplished through a gastrostomy, it would be much better to do an antethoracic plastic operation, forming a new tube by means of a skin flap from the neck to the gastric stoma (Braizev).<sup>25</sup> Perforations of the œsophagus occur after or due to instrumentation.<sup>26</sup> I have seen four such accidents. They are almost unavoidable. They have not all been due to my own unaided efforts. One case, in which I felt personally responsible, recovered shortly. The other three were fatal.

*Treatment of Cardiospasm.*—Under this heading may be included the treatment of megalo œsophagus, which has required plication of the œsophagus.<sup>27</sup> The œsophagus has also been anastomosed with the stomach through an enlarged opening made in the diaphragm (Lambert).<sup>27a</sup> Forcible stretching of the cardia through the stomach; plastic operations upon the cardia drawing it down into the abdominal cavity;<sup>28, 28a</sup> extra mucous section of the cardia similar to the Rammstedt operation on the pylorus;<sup>29</sup> all have been performed.

If one knew the specific cause of cardiospasm the attack would be more direct. My belief is that cardiospasm is largely a reflex response to some irritation, the spasm probably being a symptom rather than a disease. The symptom however is what causes the distress and this has to be remedied. Dilatation of the cardiospasm by means of the Plummer method or the Vinson hydrostatic dilator or the glove stretcher dilator of William Lerche, or its modification, carried on after inspection by the œsophagoscope, is at present the method of choice. This primary dilatation must often be followed up by repeated dilatations by large-sized bougies. In many instances

the patient will go for months, sometimes years without further bouginage. If the irritation causing the spasm is due to a small ulcer near the cardia, direct application of a silver nitrate solution is indicated. If gall-stones are present causing reflex spasm this cause should be removed.

*Treatment of Diverticula.*—Obstruction caused by a diverticulum is cured by treatment of the diverticulum. Dilatation may be used as an aid to overcome contraction after removal. Where a pouch occurs at the upper end of the œsophagus, the diverticulum is attacked through the neck, preferably on the left side. The treatment is best carried out in two stages. The first stage isolates the diverticulum and packs around it without opening it. The second stage removes the sac ten days later. (M. Martens recommends tying off the diverticulum with strong thread at time of primary operation and says it will slough off ten to twelve days later.)<sup>30</sup> By this sequence there is little danger of either a mediastinitis or a new false sac being formed by the opening up of the œsophagus at the site of the neck of the diverticulum. This procedure is well done under local anæsthesia. Where the diverticulum occurs at the lower end of the œsophagus, as it does in rare cases, surgical removal appears too drastic for the discomfort caused by the abnormality. In such a case cardiospasm may occur concomitantly. Treatment of the cardiospasm will ameliorate the patient's distress. Traction diverticula in the middle third of the œsophagus are not large and the treatment of these must be conservative and palliative. Functional diverticula have been noted which have apparently disappeared without treatment (Barsony).<sup>31</sup>

*Foreign Bodies.*—Removal of foreign bodies is done in most cases with the aid of the œsophagoscope. When the foreign body cannot be grasped by the forceps, it can be successfully pushed down into the stomach.<sup>32</sup> There it may be removed surgically or it may remain in the stomach or pass out the natural way. When it could not be removed by the 'scope or pushed into the stomach the attack has been made through the stomach, introducing the hand and reaching the fingers up through the cardiac orifice into the œsophagus and bringing out the foreign body in this way (Hesse).<sup>28</sup> In all my cases the foreign bodies have been successfully removed or dislodged by means of the aid of an œsophagoscope.

It has been my good fortune to have gratified my interest in these cases for over twenty-one years and I here desire to express my appreciation to my many associates who have given me the privilege of seeing cases with them aside from my own personal cases.

By report of the record clerk at St. Luke's Hospital, for ten years ending January 31, 1928, thirty-seven personal cases are ascribed to me of carcinoma of the œsophagus. Of these four were females; thirty-three were males. Gastrostomies of one kind or another were performed in twenty-four cases. Three had no operation. Twenty-one were discharged "improved." Ten died in the hospital. Four were discharged "unimproved." Of the three who had no operation, one was discharged "unimproved." Of the gastros-



tomies eight died in the hospital. There were seven Janeway gastrostomies noted; of these one died in the hospital. One case had a jejunostomy. Of the other cases operated upon for a gastrostomy and not specified as of the Janeway type seven died. In the same period there were twenty-three additional cases noted on both surgical services. Of these nine died in the hospital, eight were discharged "improved" and six "unimproved." For this class of cases the stay in the hospital was no criterion of end results.

From January, 1919, to January, 1928, inclusive fourteen personal cases out of fifteen total benign strictures of the œsophagus are reported. Of these eleven were discharged "improved." One died after a jejunostomy, and one died after repeated and painstaking effort to get a filiform bougie into the stomach and an attempt to effect a retrograde passage. He was in the hospital several months. This case would have been better treated by an ante-thoracic œsophagoplasty. One was discharged unimproved and without operative procedure. Many of these cases received follow-up treatment and were cured at a later date. The fifteenth case was discharged "unimproved" without operation.

Of foreign bodies in the œsophagus there were thirteen personal cases reported out of seventeen on all the services. Sixteen were discharged cured. One was "improved."

There were in all eight cases of diverticulum of the œsophagus, all of whom were discharged improved or cured. One of these reëntered the hospital some months later and died of pneumonia at an advanced age. One of the most satisfactory cases was that of a patient of Dr. John Douglas, operated upon by him. In this case I had the privilege of being associated with him.

There were twelve personal cases out of the thirteen cases of cardiospasm reported. There was one case of cardiospasm complicated with œsophageal diverticulum (case of Dr. Morris K. Smith). All were discharged as either cured or improved. Œsophagoscopy and dilatation was the method employed.

These foregoing cases represent cases at St. Luke's Hospital under my care. Cases seen in other institutions have not been included in this list. As a rule these œsophageal cases come from the more unfortunate walks of life. Perhaps, in the case of strictures and foreign bodies because they are unguarded in their home surroundings. The economic factor seems to be a contributing cause.

#### CONCLUSIONS

The early differential diagnosis between the various forms of benign stenosis will indicate the timely treatment of the patient. Mistaken or late deferred diagnosis may even in these cases lead to a fatality (Brücke).<sup>33</sup>

In most cases of cicatricial stenosis, per-oral instrumentation is sufficient. In the more impermeable strictures it is better to augment this or replace it by more incisive surgery, such as gastrostomy or ante-thoracic œsophagoplasty.

Foreign bodies can usually be removed per-orally and without harm.

A diverticulum originating at the pharyngo-œsophageal junction is best operated upon in two stages or at least in such a way that the act of deglutition may not rupture through the neck of the sac until the cellular tissues are protected by granulations.

Cardiospasm may be controlled by forcible dilatation and if necessary followed up by occasional *bouginage*. If there is a visible cause for the spasm it should be removed. Seldom is it necessary to resort to open surgery. Anti-spasmodics are of little use.

The early differential diagnosis between benign and malignant stenoses is vital.

Palliative treatment of malignant stenoses is always closed by fatality.

In the radical treatment of cancers of the œsophagus lies the hope of cure. The immediate mortality of resection of the œsophagus for malignancy is still high, but several cases have now made recoveries. (In the early days of gastrostomy the mortality was also high.)

In the early diagnosis of the disease and quick transference of responsibility to the surgeon lies definite hope of cure.

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# TESTS OF HEPATIC FUNCTION IN CARCINOMA; THEIR VALUE IN CASES OF NEOPLASM OF THE COLON WITH AND WITHOUT METASTASIS TO THE LIVER\*

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LABORATORY tests of hepatic function, as indicative of the capacity of the liver to carry on work, although frequently of limited clinical usefulness, nevertheless are important additions to the clinician's armamentarium. As a means of demonstrating metastatic lesions in the liver, secondary to primary growths in the colon and rectum, we have thought it might be of some significance and interest to follow a series of cases in which the exact pathologic changes could be demonstrated at operation in the hope that a definite curve might be established whereby more confirmation than a suspicion might be available in certain cases of borderline operability. In this study, the results of bromsulphthalein tests, the van den Bergh reaction and the estimation of bilirubin content of the serum have been reviewed in detail. The technic of these various tests is too well known and has been reported previously too often to require repetition.

The series under consideration is a review of 116 consecutive cases of carcinoma of the colon and rectum studied in regard to the value of these tests as evidence of metastatic implantation in the liver.

Ascites was not found in any of the cases. It is a relatively uncommon complication of malignant disease of the colon. When present in such cases, it is indicative of peritoneal rather than hepatic involvement. Such patients would not be suitable subjects for operation, and therefore would not be included in the present series of cases.

In this series of 116 cases, eighty-two of the patients were men and thirty-four women. The ages of the men varied from nineteen to seventy-five years and those of the women from thirty to seventy-three years. The duration of symptoms varied from one to ninety-six months. The situation of the lesion was variable. In nine cases the lesion was in the cæcum, in the ascending colon, or at the hepatic flexure; in four, in the transverse colon; in three, in the splenic flexure or descending colon; in thirty-one in the sigmoid or rectosigmoid portions of the colon, and in sixty-nine, in the rectum. This distribution of the lesions corresponds well with that reported by previous writers, as summarized by Rankin. In all cases the age of the patient, loss of weight, duration of symptoms, situation and size of the

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\* Submitted for publication November 27, 1929

TABLE I  
*Value of Bromsulphthalein Test of Hepatic Function in Fifty-two Cases of Carcinoma of the Colon Both With and Without Hepatic Metastasis*

Group	Case	Age, years, and sex	Duration of symptoms, months	Loss of weight, pounds	Duration of loss of weight, months	Situation of lesion	Degree of obstruction	Size of primary lesion, cm.	Type of lesion	Grade of malignancy	Degree of involvement of liver	Retention of bromsulphthalein, per cent.	
												30 minutes	60 minutes
1	1	63F	36	20	5	Sigmoid	None		Colloid carcinoma		Right lobe a mass of carcinoma	24	64
	2	34M	12	25	12	Rectum	Moderate				Several nodules in right lobe	22	22
	3	36M	1	25	1	Sigmoid	Complete				Filled with metastasis	36	26
	4	34M	2	6	1	Sigmoid	Moderate	5x6x1	Carcinoma		Numerous large tumors	12	12
	5	60M	18	18	14	Sigmoid	None				Extensive involvement	32	28
	6	61M	12	35	12	Rectum	Moderate				Extensive metastasis	40	16
	7	75M	2	20	6	Rectum	Moderate				Three tumors	16	12
	8	38F	6	30	3	Sigmoid	Complete				Several large nodules	12	12
	9	48M	3	30	3	Descending colon	None	8x6x3	Adenocarcinoma		A small nodule	16	10
	10	62M	6			Transverse colon	Moderate				Filled with metastatic nodules	18	5
2	11	51M	24	40	24	Sigmoid	Moderate		Adenocarcinoma	3	Filled with carcinoma	4	2
	12	55F	4	20	4	Rectum	Moderate				A metastatic nodule on edge of right lobe	6	3
	13	30F	9	8	3	Rectum	Complete				Large metastatic nodule in right lobe	4	
	14	30F	6	6	6	Sigmoid	Moderate				Multiple metastatic nodules in both lobes	4	
	15	45M	24	6	6	Rectum	Moderate		Adenocarcinoma	2	Nodule in right lobe		2
	16	67M	6	6	6	Rectum	Moderate				Numerous metastatic nodules throughout		4
	17	39M	6	20	6	Rectum	Marked		Adenocarcinoma	2	Numerous metastatic nodules	8	2
	18	47M	5	30	5	Rectosigmoid	None		Adenocarcinoma	2	Filled with metastasis	8	2
	19	50M	3	5	3	Rectum	Moderate	6x6x1.5	Adenocarcinoma	2	One nodule in right lobe and one in left lobe	4	
	20	68M	12	12	12	Rectum	Moderate		Adenocarcinoma	2	Nodule in superior portion of right lobe	4	2
	21	71M	8	5	8	Rectum	None	4x5x1.5	Adenocarcinoma	2	One small nodule	4	
	22	48F	36			Sigmoid	Marked		Adenocarcinoma	2	Extensive involvement by carcinomatous nodule	8	4
	23	58M	15	18	4	Rectum	Moderate	2	Adenocarcinoma	2	Carcinomatous nodule of right lobe		
	24	63M	4			Rectum	Moderate		Carcinoma	2	Filled with metastasis	4	2
	25	61M	3	20	3	Rectum	None		Adenocarcinoma	2	Extensive metastasis	52	48
	26	51M	6	20	6	Sigmoid	Moderate		Adenocarcinoma	4	Extensive metastasis, large round nodules throughout liver	36	32
	27	62M	4	8	4	Rectum	None				Many metastatic nodules	42	36

TESTS OF HEPATIC FUNCTION IN CARCINOMA

3*		4*		5*		6*		7*		8*		9*		10*		11*		12*		13*		14*		15*		16*		17*		18*		19*		20*		21*		22*		23*		24*		25*		26*		27*		28*		29*		30*		31*		32*		33*		34*		35*		36*		37*		38*		39*		40*		41*		42*		43*		44*		45*		46*		47*		48*		49*		50*		51*		52*		53*		54*		55*		56*		57*		58*		59*		60*		61*		62*		63*		64*		65*		66*		67*		68*		69*		70*		71*		72*		73*		74*		75*		76*		77*		78*		79*		80*		81*		82*		83*		84*		85*		86*		87*		88*		89*		90*		91*		92*		93*		94*		95*		96*		97*		98*		99*		100*	
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primary lesion, degree of obstruction, type of carcinoma, grade of malignancy, and evidence of hepatic involvement noted on clinical examination were recorded. These data were compared with the apparent degree of hepatic involvement noted by the surgeon at the time of operation, and with the results of the various tests of hepatic function.<sup>1</sup>

For study of the value of hepatic functional tests, the cases were divided into four groups on the basis of the conditions found at operation: (1) those with metastasis to regions adjacent to the primary lesion (local metastasis) and with metastasis to the liver, twenty-four cases (20.6 per cent.); (2) those with metastasis to the liver alone, fourteen cases (12.0 per cent.); (3) those with local metastasis alone, forty-nine cases (42.5 per cent.), and (4) those without local metastasis or metastasis to the liver, twenty-nine cases (25.0 per cent.). A summary of the data in the four groups is given in Table I.

### *Results of Bromsulphthalein Test.*

The number of patients in each group was too small to permit of sharp distinction between the conditions found in groups 1 and 2, or between

TABLE II

*Distribution of Cases in Accordance with Different Degrees of Retention of Bromsulphthalein*

	Cases	Normal		Borderline		Pathologic retention	
		Cases	Per cent.	Cases	Per cent.	Cases	Per cent.
Group 1.....	24	13	54.5	2	8.0	9	37.5
Group 2.....	14	5	35.7	3	21.5	6	42.8
Group 3.....	49	41	83.6	2	4.0	6	12.4
Group 4.....	29	25	86.0	2	7.0	2	7.0
Total.....	116	84	72.4	9	7.7	23	20.0

\* Cases were classified under the headings "normal," "borderline," or "retention," in accordance with the percentage of dye retained after thirty minutes and sixty minutes respectively. Accordingly, retention in normal cases was less than 10 and 5; in borderline cases more than 10 and 5, but less than 20 and 10; in cases of pathologic retention more than 20 and 10.

those found in groups 3 and 4. However, there is considerable difference between the conditions found in groups 1 and 2 combined, in which there was hepatic metastasis, and in groups 3 and 4 combined, in which this factor was absent. In half of the cases of hepatic metastasis there was retention of bromsulphthalein and this was marked in approximately 40 per cent. of the cases.

Of the cases in groups 3 and 4 combined, on the other hand, 85 per cent. gave a normal response to the bromsulphthalein test, and marked retention was found in only 7 to 12 per cent. of the cases. The liver was reported as being normal in 78.6 per cent. of those cases in this study in which a normal response to the bromsulphthalein test was obtained. On the other hand, metastasis to the liver was found in 65.2 per cent. of those cases in which there was marked retention of the dye (Table II).

Several factors are concerned in the elimination of bromsulphthalein from

the blood stream by the liver. Greene, McVicar, Walters and Rowntree, in their study of the closely allied substance, phenoltetrachlorphthalein, pointed out that a positive test is a measure of the interference with the activity of the liver as a whole, and that until there is some infringement of the normal reserve, functional disturbance cannot be expected. This is particularly true when one is dealing with a sharply localized lesion, such as a single metastatic nodule. The presence of a metastatic nodule is of great significance to the surgeon in its relation to the alternate prognosis of the patient, yet at the time when it is merely a nodule it in no way reduces the functional efficiency of the liver.

Similarly, the fact that the surgeon did not observe metastasis on the surface of the liver does not exclude its presence within the substance of the organ. This may serve to explain the retention of bromsulphthalein in some of the cases in which the liver did not appear to be involved in the carcinomatous process. Other factors may also serve to explain this apparent disturbance in hepatic function in these cases.

Bromsulphthalein is rapidly eliminated from the blood stream by normal individuals. Patients in hospital without any apparent disease of the liver may eliminate the dye less readily and among them a wider range of variation in the response to the test is present than among medical students or nurses. If allowance is made for this variability in patients in hospital, there is usually no difficulty in demonstrating pathologic changes in the liver in patients by whom bromsulphthalein is retained in the blood stream.

Although a normal response to the bromsulphthalein test generally is obtained in the serum of patients in hospitals, the condition of the patient may affect the response to the test. Cardiac decompensation, with resultant passive congestion of the liver, quickly produces moderate retention of the dye; this phenomenon quickly disappears as the circulation is reëstablished. Similarly we have noticed in the present series of cases that retention of dye is frequently observed in the patient with symptoms of marked intestinal obstruction, who enters the hospital in a seriously weakened condition as a result of prolonged vomiting and dehydration. Moderate retention of bromsulphthalein may be present in such a patient when he is admitted to the hospital, and yet a normal response may be obtained a few days later, after adequate medical care and consequent improvement in the general condition of the patient. An extreme degree of fatty infiltration is frequently observed in the livers of patients who die after operations for the relief of obstructive lesions of the colon or rectum. A diffuse lesion such as this fatty infiltration may serve to explain the occasional occurrence in this series of apparent disturbances of hepatic function in the absence of metastasis to the liver. In such cases, however, the clinical condition of the patient should give the clue to the correct interpretation of the bromsulphthalein test.

A negative bromsulphthalein test will not exclude the possibility of metastatic involvement of the liver in a case of carcinoma of the large intestine; on the other hand, retention of the dye, especially when the clinical condition



of the patient is considered and there are other signs of hepatic involvement, may be diagnostic of metastasis.

CASE I.—A woman, aged sixty-three years, came to the clinic July 18, 1928, with a history of intermittent passage of blood-streaked stools over a period of four and a half months with occasional attacks of abdominal cramps and "diarrhœa." Until four weeks prior to admission she had passed, on an average, two soft stools daily, but in the course of the four weeks previous to admission she had had more cramps and more diarrhœa, and the stools had been streaked with blood.

On admission, it was found that the patient apparently had lost weight; her usual weight of 175 pounds had been reduced to 155 pounds. The only other general observation was a faint icteric hue to the skin. The hæmoglobin was estimated as 74 per cent. by the Dare method; erythrocytes numbered 5,230,000 and leucocytes 10,300 in each cubic millimetre. Urinalysis gave essentially negative results. Röntgenogram of the thorax did not reveal abnormality. Proctoscopic examination revealed a lesion just above the rectosigmoid juncture about twenty centimetres from the anus, which was thought to be malignant. The liver was not palpable, even with deep inspiration. Exploration, August 1, revealed a distinct icteric tinge to the tissues as the abdomen was opened. The right lobe of the liver was found to be "a mass of cancer." There was a malignant growth of fair size in the sigmoid. In view of the fact that there was no obstruction, the abdomen was closed without further operation.

In this case a metastatic malignant condition was suspected because of a high degree of retention of dye.

CASE III.—A man, aged thirty-six years, came to the clinic March 25, 1928, stating that he had felt perfectly well until one month before admission. However, he had used cathartics daily for many months. During the month prior to admission his appetite had been poor. Four days before admission he had had great difficulty moving the bowels, and had gone to the toilet three or four times daily to accomplish only incomplete evacuation. Following this, there had been abdominal cramps in the upper part of the abdomen, to the left of the median line, associated with much borborygmus. The next day, he had vomited three or four times. He had stopped eating and the abdominal pain had subsided.

On admission the patient appeared to be a fairly well developed man, 5 feet and 10 inches tall, weighing 160 pounds. His usual weight had been 180 pounds. In examination of the right upper quadrant of the abdomen the liver appeared to be enlarged; the margin of the liver was irregular. There was a rounded, hard mass in the region of the sigmoid. At this time, hæmoglobin was estimated at seventy-four per cent. by the Dare method; erythrocytes numbered 4,320,000 and leucocytes 8,600 in each cubic millimetre. A röntgenogram of the thorax gave negative results. The test of hepatic function showed retention of dye, graded 3, there was retention of bromsulphthalein at the end of thirty minutes of thirty-six per cent., and at the end of sixty minutes of twenty-six per cent. Exploration, March 28, after the usual preoperative preparation, revealed an inoperable carcinoma of the sigmoid, with the liver full of areas of metastasis.

In this case the palpable liver superimposed on the intestinal symptoms, caused the examiner to suspect a metastatic condition in the liver.

CASE XV.—A man, aged forty-five years, came to the clinic April 4, 1928, complaining of increasing "constipation" for two years. He had always had a sedentary occupation, and had had some trouble with movement of the bowels. However, in the last two years, in addition to the difficulty in moving the bowels, there had been some rectal pain, tenesmus and strain. He had used many kinds of laxatives and enemas. Nine months prior to admission he had noticed some rectal bleeding, and after consulta-

tion with a surgeon he was given treatment by ultraviolet light and an anticonstipation diet. There was some improvement in movement of the bowels but the bleeding continued. He consulted another physician a month before admission and a minor rectal operation was done. In the four weeks prior to admission he had averaged a bowel movement every hour and there had been more and more difficulty in passing the stool.

Examination revealed a man who had not lost weight, although he was somewhat pale. Nothing unusual was found except a mass in the upper third of the rectum, the motion of which was limited. Proctoscopic examination confirmed this. The blood count and urinalysis were negative. The Wassermann reaction on the blood was negative. Röntgenograms of the thorax were negative. Exploration, April 9, showed a large, rather fixed lesion, and a metastatic nodule in the right lobe of the liver. Tests of hepatic function, April 5, did not show retention of dye.

In this case, there was a small metastatic nodule, but no retention of dye.

CASE XL.—A woman, aged fifty-six years, came to the clinic March 3, 1928, with a history that she had "always been constipated," but that five months previous to admission this had become so marked that she had been unable to have a bowel movement without an enema or laxative. At this time she had noted marked protruding hemorrhoids which had been treated, but in spite of treatment the gas, distress and distention had become progressively worse. Her weight had gone from 119 to 105 pounds between October and January. In the six weeks preceding admission there had been involuntary passage of gas, and some bleeding when the rectal tube or enema tip was passed.

When the patient was admitted she had not had a bowel movement for four days. Examination revealed that she was emaciated and weak. The abdomen in general was markedly distended and there was local distention, as of a coil of bowel in the left lower part of the abdomen. There was much borborygmus and much discomfort, although no severe pain. Blood pressure was 150 systolic and 82 diastolic, measured in millimetres of mercury, and the hæmoglobin was estimated at seventy per cent. by the Dare method. Erythrocytes numbered 3,760,000 and leucocytes 15,900 in each cubic millimetre. The proportion of polymorphonuclear neutrophils was eighty-one per cent. Test of hepatic function showed retention of dye, graded 3; retention of bromsulphthalein at the end of thirty minutes was thirty-six per cent. and at the end of sixty minutes, thirty per cent. Cecostomy, for subacute intestinal obstruction, secondary to carcinoma of the rectum, was performed March 6; a nodule was removed from the parietal peritoneum near the wound. The patient died March 26 from generalized peritonitis, and at this time metastasis to the liver was not found.

In this case the cause of retention of the dye was other than a malignant condition.

*Results of the van den Bergh reaction and of investigation of the concentration of serum bilirubin.*—Clinically demonstrable jaundice was found in only one case. In this case the concentration of serum bilirubin was increased, and a direct van den Bergh reaction was obtained. The cases in which the bilirubin content of the serum was normal also gave a direct van den Bergh reaction. Although this reaction is usually significant of hepatic disturbance, it did not occur with sufficient frequency to be of diagnostic significance in the present series of cases.

#### COMMENT

In about fifty per cent. of patients with extensive hepatic metastasis, proved surgically, metastasis was suspected from general examination. Notes

such as the following appeared frequently on the clinicians' résumé of the results of examination: "epigastric fullness with mass" (Case VII); "liver large and irregular" (Case III); "mass in upper abdomen, liver edge tender and irregular" (Case XXV); "liver is nodular and lower edge three fingers below costal margin" (Case XXVI). Furthermore, retention of dye in these cases was usually marked. There were other cases in which the liver was not palpable, even with deep inspiration, but in which the surgeon found the liver riddled with metastatic lesions and in which there had been a high degree of retention of dye before operation.

It seems evident, then, that the test of hepatic function may add valuable information to confirm a clinical suspicion and also that it may raise suspicion and urge one to exhaust clinical means of diagnosis of metastasis to the liver.

We do not anticipate withholding surgical intervention in many cases as the result of this study. Yet, when the lesion is large, especially if it is possible to see it by means of the proctoscope, if it is questionably operable, if we can be certain that metastasis to the liver has taken place, and if there is no obstruction, a patient may be spared an exploration. We hope that this investigation will stimulate earlier recognition of malignant lesions of the large intestine, so that more and more cases may come to the surgeon at a time when the lesion of the colon is resectable.

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# LIPIODOL STUDIES OF POST-OPERATIVE BILIARY FISTULÆ

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DURING the past two years, we have on a number of occasions injected lipiodol into post-operative biliary fistulæ and then made radiological studies of the biliary tract. When the plates indicated the presence of pathological conditions we had the opportunity of checking them against the operative findings. We believe that the results have been of sufficient interest and importance to warrant their being reported.

*Technic of injection.*—In order to evaluate correctly the anatomical conditions present, sufficient lipiodol to distend the ducts must be injected. Following the suggestion of Dr. A. J. Bendick, in his work on Utero-Salpingography, we have in our later cases made the injections under fluoroscopic control. We would like to stress this particular point of technic. It gives a fairly accurate idea of the flow of the injected fluid, prevents over-distention, and reveals any false dissection of the tissue spaces.

Prior to the injection, the lipiodol is warmed, and whatever bile is present in the sinus is aspirated. If a tube is still in situ, gravity will suffice to outline the ducts. The tube should be removed, however, before a plate is taken, as it may obscure the picture.

Usually, however, the patient is seen with a small skin opening and a tortuous narrow tract. In these cases it is frequently necessary to use some degree of pressure in order to force the lipiodol into the duct system. For this purpose we use a "Triumph" syringe with a rubber urethral tip attached to its nozzle, and inject under fluoroscopic control.

A few minor points in technic deserve emphasis. The skin should always be wiped dry of lipiodol before the plate is taken, or confusing super-position of shadows may occur. In cases where there is a tendency for the contrast medium to pool in the subcutaneous tissues a marker should be placed to identify that site. Finally, in order to prevent the exit of the injected fluid, the sinus should be plugged and strapped over.

We have in our series encountered no untoward effect from the injection of the lipiodol either locally or generally. Even in cases where we have injected under considerable pressure and where there has been no communication with the duodenum, later plates have shown that the lipiodol completely disappeared from the intra-hepatic biliary radicles. Whether this is due to reflux through the sinus or whether the hepatic cells have the power of absorbing lipiodol, we are unable to state. Wälzel<sup>1</sup> reports an experiment in which lipiodol was injected into the intra-hepatic biliary system of a dog.

in whom the common duct was divided and infolded. Examination of the liver a few days later, showed no evidence of lipiodol. In cases where there is a direct communication between the duct system and the duodenum we have noted no evidence of gastro-intestinal irritation even when lipiodol has been used in quantities up to twenty cubic centimetres. Mallet<sup>2</sup> reports a case where abdominal pain, vomiting, and fever followed the injection of lipiodol into a common duct which was not occluded, but in which he found evidence of dilatation just proximal to the papilla of Vater. He attributes the symptoms to regurgitation through the duct of Wirsung.

We have not made any injection in the presence of fever, and believe

that it would be inadvisable to attempt one in the face of any active infectious process in the liver or ducts.

*Interpretation.*—The persistence of a post-operative biliary discharge following cholecystectomy may be a source of considerable anxiety to the surgeon. In the majority of instances it will prove to be merely an annoying minor sequel serving to prolong convalescence. In some instances, however, it is the external evidence of an obstruction to the normal flow of bile. Failure of a biliary fistula to close will therefore bring up the question of the presence of an obstruction, its site and its nature



FIG 1.—No obstruction in biliary tract. Plate taken immediately after injection of lipiodol, illustrating rapid emptying into duodenum and failure to outline intrahepatic biliary radicles. No obstruction. 1. Common duct. 2. Duodenum with characteristic serrations. 3. Tube in biliary fistula. Spontaneous closure of sinus.

Considerable light may be obtained on all these points by an injection of lipiodol.

If no obstructing lesion is present the injected lipiodol will pass almost immediately into the duodenum. (Fig 1.) The sphincter of Oddi does not seem to offer any resistance to its onward flow. Only a few of the primary hepatic ducts are outlined. In the absence of an obstruction it is impossible to outline the intra-hepatic biliary radicles to any extent, as the flow meets with much less resistance distally than centrally. So rapidly does the lipiodol pass into the duodenum that the entire common duct is rarely outlined completely. The duodenum is recognized by its serrated edges due to its

normal folds and by the peristalsis stimulated by the inflow of the fluid into its lumen. At times the lipiodol passes very rapidly into the jejunal loops, lying on the left side of the abdomen, so that the presence of the opaque fluid in the intestine may be overlooked unless the röntgenogram includes the entire upper abdomen.

When no obstruction can be demonstrated an early spontaneous closure of the fistula may be anticipated. Parenthetically we may state that in one case where the plates showed no obstruction three weeks post-operatively, and where premature exploration was nevertheless performed at another institution shortly thereafter, no cause for the persistence of the sinus could be established. In five cases where the lipiodol showed no obstruction in the bile passages, the biliary discharge gradually ceased and the sinus closed without further intervention.

When an obstruction is present distal to the internal fistulous opening, a different picture is met with. (Fig. 2.) The lipiodol, meeting resistance distally, backs up into the proximal biliary radicles; and may outline the entire biliary tree. This is especially true in obstructions in the hepatic duct. When the obstruction is low

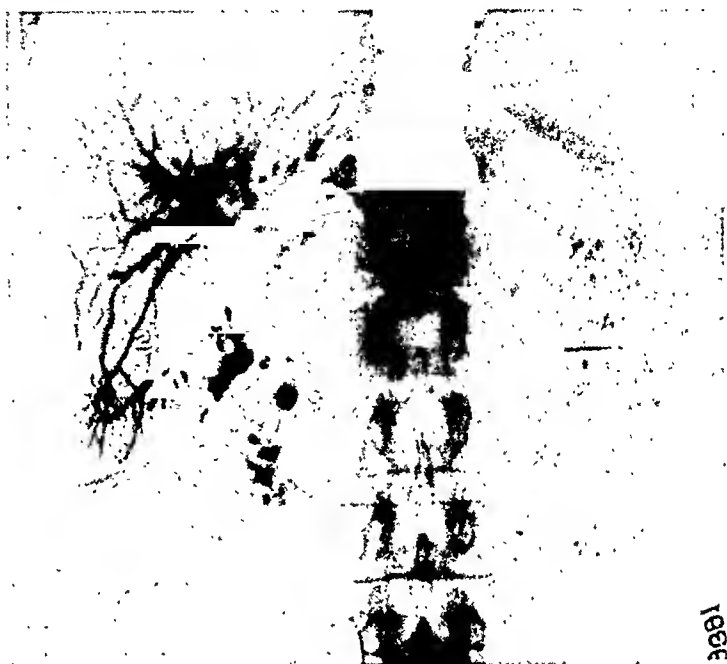


FIG. 2.—Case I. Illustrating injection through abdominal post-operative biliary fistula of two months' duration with incomplete stricture of the common duct. 1. Tube in sinus tract. 2. Stump of gall-bladder. 3. Common duct with small quantity of lipiodol passing into duodenum. The hepatic ducts down to the very fine intrahepatic biliary radicles are outlined due to reverse flow above the stricture.

down in the common duct, the dilatation of the duct may be so great that it will accommodate all the injected lipiodol and one hesitates about injecting more fluid to outline the intra-hepatic radicles. If the obstruction is complete no lipiodol will be visualized in the intestine either immediately or in later pictures. With an incomplete obstruction small quantities of fluid will slowly trickle through to the duodenum. (Fig. 2.) Lipiodol will demonstrate not only complete obstructions where the stool is acholic but also incomplete obstructions where the stool contains bile. It will thus demonstrate incomplete strictures and non-impacted stones.

The nature of the obstruction must be arrived at by inference. The most common causes post-operatively are retained stone and complete or incomplete stricture. A small overlooked carcinoma of the head of the pancreas or of the papilla of Vater may at times be the cause. Post-operative strictures, usually traumatic in nature, occur practically only in the supra-

duodenal portion of the duct and most commonly at the junction of the cystic and hepatic ducts. Retained common duct stones on the other hand, cause obstruction near the papilla. An obstruction high in the common or hepatic duct is more likely to be a stricture. Obstruction low down where the whole common duct is distended and visualized is more likely to be due to a stone. A stone may, but does not necessarily, cause a filling defect in the lipiodol shadow. It is more apt to do so if tightly wedged in a small duct where the lipiodol cannot surround it, than if it is lying in a distended one where the dense lipiodol shadow will obliterate all finer details.

In addition to its diagnostic value, the lipiodol may be of some assistance in determining the operative procedure. Thus, in a case seen recently at another institution, the stump of the hepatic duct was seen to be so short that any attempt to anastomose it to the duodenum or lower portion of the common duct was almost certainly foredoomed to failure. As the sinus tract was seen to be patent and offered no obstruction, it was determined to turn it into the stomach, which was done with excellent results.

On the other hand, a picture such as Fig. 2 would indicate that an anastomosis of the stump to the lower end of the duct or to the duodenum was technically feasible and that the sinus need not be conserved. Similarly, by indicating the obstruction near the papilla the exploratory procedure may be considerably simplified by being commenced at the second portion of the duodenum.

Brief reports of a number of our cases are appended:

CASE I.—(Fig. 2.) H. F., female, age forty-five, entered the Mount Sinai Hospital August 8, 1927. Two months before admission, a cholecystectomy had been performed since which time a biliary discharge had persisted. On two occasions since her operation, she had experienced chills and fever, but had not been jaundiced. Examination revealed a profuse biliary discharge from a right upper quadrant sinus. The stools contained small amounts of bile, but were light colored. Clinically she was not icteric and the van den Bergh test showed a normal blood bilirubin.

A lipiodol study of the biliary system was undertaken. The plates showed an area of constriction in the common duct. Above this point there was a reversal of flow into the intra-hepatic biliary radicles, but small quantities of contrast medium were visualized in the common duct and duodenum. A small diverticulum connected with the hepatic duct was outlined. This was interpreted as being the stump of the gall-bladder. Apparently an obstruction was present high in the common duct just distal to the entrance of the cystic. The site of the obstruction made it likely that it was a stricture.

Soon after this the biliary fistula closed, proving incidentally that an incomplete obstruction will not necessarily produce a permanent fistula. Observation in the follow-up clinic revealed that the stool contained bile, but the patient would occasionally have attacks of chills, fever and jaundice. Readmission was advised, but the patient procrastinated.

In April, 1928, ten months after her original operation and eight months since the demonstration of an incomplete stricture of the common duct, the patient reentered the hospital very acutely ill. She had suffered a number of shaking chills, her temperature was 104° F. and an obstructive jaundice was present. Blood culture showed the presence of *B. Coli*. A choledochotomy and drainage for suppurative cholangitis was performed. The presence of the following pathological conditions was determined at operation. (C. F. Fig. 2.)

1.—A complete obstruction in the upper portion of the common duct, due to stricture. 2.—A dilated hepatic duct containing pus and bile. 3.—A small pouch containing bile and apparently communicating with the hepatic duct, probably stump of gall-bladder.

Because of the condition of the patient, no serious attempt was made to find the lower portion of the common duct.

The patient was discharged with a complete biliary fistula and allowed to drain for eight months. At that time, she was re-operated, the lower portion of the common duct found, and an end to end anastomosis established over a tube. The patient has been well to date.

CASE II.—(Fig. 3.) C. L., female, age thirty-eight, was admitted to the Mount Sinai Hospital in April, 1929, with a freely discharging supra-hepatic biliary sinus, situated at the anterior extremity of a healed wound in the eighth intercostal space.

Six months ago, a cholecystectomy had been performed for acute cholecystitis and cholelithiasis. Shortly thereafter, a biliary discharge had appeared through her abdominal wound. Fever, and jaundice then developed which had persisted for three weeks at which time a sub-phrenic abscess containing bile stained pus was drained through a trans-diaphragmatic incision. Following this, the fever and jaundice had disappeared. The discharge from the *abdominal* sinus had gradually diminished and finally ceased, but the flow of bile from the *thoracic* wound had become more profuse and constant.

Under fluoroscopic control lipiodol was injected through the sinus and immediate plates were taken. Under the screen, the lipiodol was seen to outline the ducts of the right lobe of the liver, meet an obstruction and reverse its flow into the biliary radicles of the left lobe.

The plates (Fig. 3) showed the main ducts of the intra-hepatic biliary system well injected with a marked enlargement of the left lobe of the liver. The common hepatic duct was somewhat dilated in its upper portion. The lower portion showed two constricted areas below that site. No lipiodol was seen in the intestinal tract. A film taken thirty-six hours later, showed most of the lipiodol to have disappeared from the intra-hepatic duct radicles, but still no lipiodol in the intestinal tract.

The impression was that a stricture was present in the hepatic duct; that there was no communication between the hepatic duct and the duodenum; and that the trans-diaphragmatic biliary fistula was complete and permanent. The irregularity seen above the stricture was thought to be due perhaps to stones above the obstruction. Operation was undertaken with the idea of re-establishing the normal biliary flow by some plastic procedure on the hepatic duct. Exploration through the right upper quadrant revealed a stricture at the junction of the common and hepatic ducts with a number of soft stones above it. The lower end of the common duct was isolated low down and an ana-

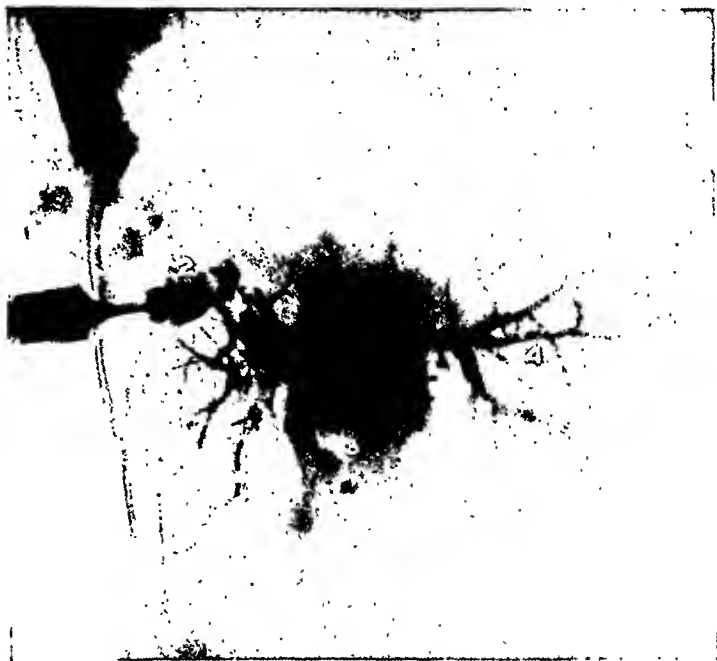


FIG. 3.—Case II. Injection through a suprahepatic sinus six months after drainage of subphrenic abscess, illustrating obstruction, complete, at or near the junction of hepatic and common ducts. Spontaneous closure of sinus impossible. 2. Triumph syringe with urethral tip in sinus opening on skin. 3. Point of obstruction near junction of common and hepatic ducts, probably stricture. (The irregularity here was found to be due to soft stones above the stricture.) 4. Hypertrophied left lobe of liver, its biliary tree outlined by lipiodol.



stomosis performed over a tube. The patient developed a duodenal fistula and deceased.

*Autopsy* showed a small right lobe of the liver, a hypertrophic left lobe, and indications that the old abscess of the right lobe of the liver communicated with the main hepatic duct.

CASE III.—(Fig. 4.) This case is presented in order to contrast the findings in Case II with the picture encountered in a supra-hepatic sinus *without* any obstruction in the duct system, and in which spontaneous closure resulted.

P. H., age forty-two, was admitted to the Mount Sinai Hospital, February 20, 1927, with signs of acute cholecystitis. Operation revealed an actually inflamed gall-bladder containing pus and bile, but no stones. No stones were found in the common duct. A sub-phrenic abscess developed

FIG. 4.—Case III. Injection through suprahepatic trans-diaphragmatic biliary sinus showing no obstruction in the extra-hepatic biliary passages. Spontaneous closure of sinus. 1. Tube in sinus. 2. Hepatic duct. 3. Stump of cystic duct. 4. Common duct. 5. Entrance of C. D. into duodenum through Papilla of Vater. 6. Loops of jejunum.

A cholecystectomy was performed. Two weeks later, a which was drained trans-diaphragmatically. A biliary discharge appeared through the inter-costal incision and continued for about one month. At this time, lipiodol was injected. The plates showed that the sinus was directly connected with the liver abscess, which in turn communicated freely with the biliary system. There was no evidence of obstruction either in the common or hepatic ducts and the lipiodol was seen to rapidly enter the duodenum. It was concluded that in the absence of any obstruction, the supra-hepatic sinus would close spontaneously, which it did, shortly thereafter.

CASE IV.—(Fig. 5.) M. D., female, age fifty-four, was admitted to the Mount Sinai Hospital April 12, 1927.

Twelve years ago, she had suffered a series of attacks of biliary colic without jaundice. She had had no further attacks until ten days before admission when these symptoms recurred; this time, accompanied by jaundice. Examination revealed slight icterus, both



FIG. 5.—Case IV. Retained stone at Papilla of Vater. Appearance four hours after injection of lipiodol. 1. Dilated C. D. with retained lipiodol. 2. Probable site of obstruction near Papilla of Vater.

clinically and with the van den Bergh test. The stool, however, contained bile. Operation revealed a chronically diseased gall-bladder containing numerous stones. A stone was impacted in the cystic duct. In the region of the pancreas, a nodular mass was felt which was taken to be either chronic pancreatitis or pancreatic neoplasm. A cholecystectomy was performed. No evidence of stones was found in the common duct.

One week later, a profuse biliary discharge appeared through the abdominal tube. This continued in varying quantities; bile was, however, present in the stool. One month later a lipiodol study of the biliary sinus was made.

The common duct was found dilated. The lipiodol did not run immediately into the duodenum and the site of the obstruction was at the papilla. A plate taken four hours later, showed the lipiodol still present in the common duct.

The patient was re-operated, one month after her original operation. No definite

cause for the persistence of the biliary fistula was found and it was thought that the lipiodol injection had furnished erroneous information. *The common duct, however, was not opened at this operation.* After the second operation, the biliary discharge continued for about one month and then ceased.

In March, 1929, almost two years after her original operation, the patient again entered the hospital. In the interim, she had experienced attacks of colic which had become much more frequent in the last few months. Five days before admission, she had become icteric. At the third operation, the common duct was opened and a *stone*



FIG. 7.—Case V. Plate taken four hours after Fig. 6. 1. Slowly emptying common duct. 2. Lipiodol in small intestine. No organic obstruction at papilla found at operation.

found near the papilla. It was the opinion of the operating surgeon, as was ours, that this stone had been present at the time of the original operation.

CASE V.—(Fig. 6.) Case V is presented to illustrate complicating factors which may enter into the interpretation of a plate and render a definite conclusion exceedingly difficult.

A. F., female, age thirty-eight, was admitted to the Mount Sinai Hospital November 23, 1928. A cholecystectomy for acute cholecystitis and cholelithiasis had been performed during the early months of pregnancy four years ago. During the past six months, she had suffered a number of attacks of severe colic, accompanied by jaundice. Re-operation, December 5, 1928, revealed a greatly dilated common duct, containing a number of small stones. The stump of the cystic duct was split down to the common, the stones removed and a tube inserted into the hepatic duct, which was drained for ten days. Following the removal of the tube, the sinus slowly closed, only to reopen a number of times. The re-opening of the sinus was preceded by chills and fever, and accompanied by a discharge of purulent bile. There were numerous attacks of colic. Four months after the initial operation, a lipiodol injection was made through a tiny tortuous sinus. A hugely dilated common and hepatic duct was outlined. Some of the lipiodol was seen to enter the duodenum almost at once. Plates taken six hours later showed that the



FIG. 8—Biliary sinus following cholecystostomy; one large and one small stone in gall-bladder showing no filling defect in lipiodol shadow. 1. Gall-bladder. 2. Sinus tract. P. Marker indicating sinus opening on skin.

common and hepatic ducts were slowly emptying themselves into the duodenum.

It was difficult in this case, to draw any conclusion. The dilatation of the common and hepatic ducts was apparently subsequent and compensatory to the cholecystectomy performed four years ago, as well as to the presence of the common duct stones removed at operation. While evacuation through the papilla was slow, it was constant, and it was thought that perhaps the delay might be functional, due to the huge dilatation of the duct system with the consequent diminution in intraductal pressure of the injected fluid. The possibility of a retained stone near the papilla

could not, however, be ruled out. Operation was therefore advised, although it was considered likely that the persistence of the sinus was due rather to a cholangitis involving the enormously dilated common duct, rather than to a retained stone. Patient refused. A few weeks later, the sinus closed and has remained closed to date. There have been no further attacks of colic, jaundice, chills, or fever. This case is still "subjudice." \*

#### CONCLUSIONS

1. The injection of lipiodol offers a safe and simple method for the study of post-operative biliary fistulæ in the absence of active infection involving the duct system.
2. The injections are best made under fluoroscopic control.

\* Since the completion of this article renewed attacks of colic, fever and jaundice necessitated further operation. No stone or other obstructive lesion was found. The common duct showed marked thickening and dilatation probably as a result of chronic cholangitic changes.

3. Biliary fistulæ which showed no evidences of obstruction in the extra-hepatic duct system closed spontaneously.

4. In the absence of obstruction distal to the internal opening of the fistulous tract, the lipiodol appears almost immediately in the duodenum, and there is no reversal of flow into the intra-hepatic biliary radicle.

5. The presence of an obstruction will prevent the lipiodol from immediately entering the duodenum and will result in a reversal of flow if sufficient lipiodol is used.

6. Lipiodol will demonstrate the presence of incomplete obstructions where the stool contains bile. Such fistulæ may close spontaneously, but the encroachment upon the lumen will most likely give rise to future symptoms.

7. The nature of the obstruction must be determined by inference. Obstruction in the hepatic or supra-duodenal portion of the common duct is more likely to be due to stricture. Obstruction near the papilla is more likely to be due to stone.

8. The presence of a stone will not necessarily cause a filling defect in the lipiodol shadow.

9. Routine examination of biliary fistulæ lasting longer than two or three weeks may result in the earlier diagnosis of strictures of the ducts.

10. In the type of greatly dilated common duct frequently found a few years following cholecystectomy, there may be a marked delay in the passage of the lipiodol into the duodenum, without the presence of any actual obstruction.

11. Lipiodol studies may help to indicate the most feasible reconstructive procedure in complete biliary fistulæ.

Thanks are due to Drs. A. A. Berg, Richard Lewisohn, and Edwin Beer for permission to report cases admitted to their services and to Dr. Harold Neuhoof for permission to make studies on his private cases. We also wish to extend our thanks to Doctor Jaches for numerous suggestions in regard to radiological technic.

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# OBSERVATIONS ON SPINAL ANÆSTHESIA\*

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SINCE the introduction of ephedrine has made it possible to keep the blood pressure at a more certain level, one of the principal drawbacks to spinal anæsthesia has been removed. For many years a number of investigators have made improvements in the technic of administration of this form of anæsthesia. These contributions are valuable in getting a more uniform success with spinal anæsthesia. The improvements embrace the whole range of details from the bore and bevel of the needle to the chemical properties and dosage of the solutions used. The medical profession is indebted to these investigators for perfecting the technical side of spinal anæsthesia as it is now generally used.<sup>1, 2, 3</sup> Following these publications a wave of enthusiasm for a revival of this form of anæsthesia has spread over the country. It is not our intention to go into a discussion of the history of spinal anæsthesia here.

We have naturally made use of spinal anæsthesia in the surgical clinics of the Strong Memorial and Municipal Hospitals of Rochester, New York. We wish to record our own impressions of a carefully studied small series of cases. These impressions are offered not with the idea of criticism of the printed statements of others, though we may seem to disagree with them on the indications for the use of spinal anæsthesia. We are in a fortunate position of not trying to prove anything in regard to any form of anæsthesia and believe that our observations are unbiased. Our series has not been large; 100 cases during the past year. Readings of the systolic, diastolic and pulse pressures, pulse and respirations have been recorded in each case, before and every ten minutes or less during the operation. The patient's condition and reactions have been observed and recorded by trained anæsthetists during and following the operation. Special attention has been given to the minor discomforts of surgical operations such as nausea, vomiting, headaches, distention, as well as to the major post-operative complications.

We have followed most of Pitkin's suggestions<sup>2</sup> from a technical standpoint and feel that a most careful technic is necessary to get ideal anæsthesia at the desired level. Very small factors such as a leaking connection may upset the calculated dosage and be responsible for a failure. We believe that a defective anæsthesia is due always to faulty technic. In our experience the most important considerations for getting the proper level are the dosage,

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\* Read before the University of Rochester Medical Society, November 11, 1929.

the extent of expansion, the rapidity of diffusion and the position of the patient. In the beginning we used neocaine crystals, but found spinocaine (Pitkin's solution) a much more reliable drug. This spinocaine is lighter than spinal fluid. For all operations below the umbilicus we have found two cubic centimetres of spinocaine (200 milligrams) to be sufficient and for operations above the umbilicus, three cubic centimetres of spinocaine (300 milligrams). With two cubic centimetres of spinocaine in the syringe we draw out spinal fluid to the four-cubic centimetre mark. This diluted mixture of spinocaine and spinal fluid is then injected into the spinal canal until only one cubic centimetre remains in the syringe. Additional spinal fluid is then withdrawn till the two-cubic centimetre mark is reached, after which the entire amount in the syringe is reinjected into the spinal canal. For the higher level, three cubic centimetres of spinocaine is drawn into the syringe and spinal fluid withdrawn to the nine-cubic centimetre mark. Six cubic centimetres of this mixture is then injected into the spinal canal. With three cubic centimetres still remaining in the syringe, spinal fluid is a second time withdrawn to the six-cubic centimetre mark after which the entire amount in the syringe is injected into the spinal canal. The spinocaine and spinal fluid may be mixed three or four times, injecting less into the spinal canal after each mixture, but we have found the method described above just as effective after trial of these additional dilutions. After expanding the drug it must be injected quite rapidly in order to get the proper diffusion. We have no exact data on this point, but plan to study it more carefully.

We feel that the lateral prone position is the best position while injecting the drug. It makes a more certain diffusion than the Trendelenberg and consequently a wider anæsthesia. We believe that the dangers of the semi-sitting position as practised in some clinics offset the advantage of a greater diffusion if spinocaine is the drug used. In our experience the level of anæsthesia is obtained within two or three minutes and cannot be much altered by changing the position of the patient after that time. After injecting the drug the patient is always lowered immediately into the Trendelenberg position both to prevent too great early diffusion and to support the cerebral circulation. The average duration of the anæsthesia is about  $1\frac{1}{4}$  to  $1\frac{3}{4}$  hours. The time can be extended by use of a higher dosage, but at best one cannot count on more than  $2\frac{1}{2}$  hours.

It is necessary for epigastric operations to get anæsthesia to the mid-thoracic level (splanchnics) in order to control visceral pain when traction is made. There may be perfect cutaneous anæsthesia to the costal margin, but this is not sufficient in the epigastric operations.

We have made a variation from Pitkin's technic in regard to use of ephedrine. In our experience the greatest drop in blood pressure comes within the first fifteen to twenty minutes after the spinal anæsthesia has been given. Consequently we now give a hypodermic injection of ephedrine sulphate 0.050 grams fifteen minutes before the spinal anæsthesia. This is given before the surgeon starts to scrub for the operation so that about

the proper time elapses. Even this bolstering effect on the pressure does not prevent a drop after the spinal anaesthesia is given.

Anaesthesia by this method is not absolutely certain, as an incomplete anaesthesia occasionally occurs through some minor technical fault. When certain surgical procedures require a longer time than was thought necessary, supplementary inhalation anaesthesia becomes essential.

The patient should receive morphine or scopolamine before the anaesthesia is given, as he may be much disturbed by the numbness in the lower limbs. The routine use of atropine should be avoided in intra-abdominal operations, as it completely inhibits the effect of the spinal anaesthesia on the intestine according to Domenech Alsina.<sup>4</sup>

Spinal anaesthesia insures perfect relaxation of the abdominal wall, and consequent ease of exposure. The stomach and intestines go into violent peristalsis and spasm so that the bowel is small, contracted and out of the surgeon's way. This effect is supposed to be due to the temporary chemical section of the preganglionic splanchnic fibres, which leaves the action of the vagus unopposed.

The surgical team must remember that the patient is conscious and remarks must accordingly be guarded. It is not safe to leave the patient without careful supervision, as the condition may rapidly change. Within the first fifteen minutes, there is almost uniformly a drop in blood pressure from ten to sixty points. It is also occasionally necessary to give supplementary inhalation anaesthesia. This means that the same staff is required when this form of anaesthesia is used.

The use of spinal anaesthesia can be recommended from an economic standpoint. This form of anaesthesia is far less expensive than the inhalation types.

Spinal anaesthesia has been advocated as the ideal anaesthetic because it is supposed to present the following advantages. 1. There is less danger of a post-operative pulmonary complication. 2. There is freedom from the usual post-operative minor discomforts. 3. There are no bad effects on the kidneys, heart and blood vessels, lungs and nervous system. 4. There is no disturbance of the general metabolism. 5. There is marked relaxation of the abdominal wall and contraction of the bowel so that technically operation is made much easier. 6. The surgeon is his own anaesthetist and less personnel is consequently required for an operation.

Some enthusiasts have claimed that it is the ideal anaesthetic for all surgical conditions below the diaphragm, including peritonitis, rupture of the viscera and traumatic shock. Others have used spinal anaesthesia for operations on the chest wall and for operations on the neck.<sup>5</sup> It has even been stated that there are no contraindications to the use of spinal anaesthesia.

It is a matter of common knowledge to students of post-operative pulmonary complications that these conditions are noted as frequently after local as after general anaesthesia.<sup>6</sup> This is one of the main arguments for the embolic theory of pulmonary post-operative involvement. A great many

investigators doubt the existence of true pathological processes in the lung due solely to irritation of inhalants. There is one possible exception where inhalation anæsthesia may be responsible for a spread of pre-existing lung pathology, *i.e.*, quiescent tuberculosis. Even here, however, there is no general agreement among pulmonary specialists. While we do not absolutely deny the possibility of inhalation pulmonary complications, it is our impression that this form must be very rare. We personally believe most of the pulmonary complications are due to preëxisting foci which have flared up; to small emboli from outside which have lodged in the lung fields; or to deficient ventilation and consequent congestion of patches of lung tissue. More and more we believe this last type of condition to be most often responsible for acute post-operative pulmonary complications and we have adopted routine hyperventilation after inhalation anæsthesia as a prophylactic measure.<sup>7</sup>

It is hard to see how spinal anæsthesia should be less frequently complicated by post-operative pulmonary complications than local anæsthesia. We cannot convince ourselves that spinal anæsthesia will prevent the flaring up of a pre-existing beginning focus; or that it will stop the spread of small emboli; or that it will not allow deficient ventilation and congestion of patches of lung.

We quote a few examples of post-operative pulmonary complications from our small series to show that these complications do occur after the use of spinal anæsthesia.

CASE No. 17222.—A man, sixty years of age, was admitted August 4, 1928, with a generalized peritonitis due to a ruptured gangrenous appendicitis. The heart was slightly enlarged, but otherwise showed no change. There were a few moist rales at both lung bases posteriorly. The blood pressure was 178 systolic and 92 diastolic. Appendectomy with drainage and enterostomy was performed under spinal anæsthesia. Perfect anæsthesia was obtained. On the third post-operative day patient developed pneumonia at the right base and pleurisy with effusion. Five days later signs of consolidation were still present, but the fluid was less in amount. There was a gradual clearing up of the lung condition and general improvement so that patient was discharged symptom free on August 29, 1928.

Here is a typical example of the flare-up of a pre-existing focus in the lung. The pre-existing focus as manifested by moist rales at the bases may have been a direct extension through the lymphatics of the diaphragm or an embolic process. This type of complication will occur no matter what kind of anæsthesia is employed.

CASE No. 17176.—A man, sixty years of age, was admitted August 8, 1928, with a complaint of bloating of the stomach. His illness had been progressive since the onset one month previously. The main features were gas and fullness in the abdomen which prevented him from eating. There was general weakness. Examination showed evident loss of weight, dryness of the skin, distention of the abdomen with fluid in the flanks, and secondary anæmia. The heart and lungs showed nothing abnormal. The blood pressure was 118 systolic, 90 diastolic. *Diagnosis*—Intra-abdominal carcinoma, source ?. Exploratory laparotomy was performed under spinal anæsthesia. The anæsthesia was perfect. Bronchopneumonic patches were discovered in both lungs, three days after



operation, and the patient died on the fifth post-operative day. Autopsy showed carcinoma of the gall-bladder with peritoneal metastases; generalized arteriosclerosis; and bilateral bronchopneumonia.

This patient was certainly a poor operative risk and would probably have developed a lung complication after any form of anaesthesia. We have no evidence from physical examination that there was any trouble with his lungs preoperatively. The point brought out here, however, is that the use of spinal anaesthesia did not prevent the pulmonary involvement.

CASE No. 2174.—A boy, eighteen years of age, was admitted February 20, 1929, with acute appendicitis. General examination was normal, but patient had had a cold in the head for the past three weeks. For this reason spinal anaesthesia was selected. Anaesthesia was perfect. An acutely inflamed appendix was removed. There was evidence of an upper respiratory infection on the first post-operative day. On the third day the temperature rose to 39° C., pulse to 100 and respiration to 32. He had paroxysms of coughing and raised greenish muco-purulent material. At times there was a little dyspnoea. Examination showed a few coarse rales over left lower chest. Röntgen-ray films revealed a graying over the left lower lobe. His condition remained unchanged for three days after which there was a gradual improvement. On the eighth post-operative day respiratory difficulty had entirely cleared. He was discharged well on March 9, 1929.

We are always hesitant about giving inhalation anaesthesia to patients who have colds and our policy is to postpone operation where it is one of election. In emergencies, however, operation is imperative. We thought this type of condition an ideal one for spinal anaesthesia. The patient developed pneumonia or congestion of the left base as evidenced by symptoms, physical signs, and röntgen-ray. The condition fortunately cleared up on inhalation therapy. This patient represents the extension of an upper respiratory infection or the deficient expansion of a portion of the lung.

CASE No. 22206.—A man, seventy-two years of age, was admitted on February 24, 1929. He fell and struck his left knee on the pavement a short time before admission. There was a complete transverse fracture of the patella with wide separation of three fragments. He had had influenza, pneumonia and pleurisy in the spring of 1928, less than one year ago. Under spinal anaesthesia, the patella was brought together and the joint capsule sutured. Anaesthesia was perfect and there were no technical difficulties. Three days after operation the temperature rose to 40° C., the pulse to 120 and the respirations to 30. There were a few coarse rales at the left base posteriorly. Röntgen-ray films showed high diaphragms, especially on the right. The degree of motion was sufficient to obscure an early bronchopneumonia on the films. The condition became steadily worse; physical signs of left lower lobar pneumonia developed; and the patient died six days after operation. Diagnosis of lobar pneumonia, left base was made. Autopsy was refused.

This is an outspoken example of a post-operative pneumonia in an individual who had been previously exposed to pulmonary disease within a year of his injury. There seems to be an increased susceptibility to pulmonary trouble when once the lung has been subjected to inflammation. The choice of spinal anaesthesia did not save this patient who from the standpoint of anaesthesia represents a poor risk.

## OBSERVATIONS ON SPINAL ANÆSTHESIA

CASE No. 20552.—A man, sixty-nine years of age, was admitted to the medical service on April 23, 1929. He was a moderately severe diabetic with arteriosclerosis. He had an ulcer on the heel and an infection between the second and third toes of the left foot. No pulsation could be made out in the arteries of the foot and it was doubtful even in the popliteal artery. On May 10 gangrene of the foot developed. A mid thigh amputation was done on May 11 under spinal anesthesia. No difficulty was experienced. On the third day post-operative there was fever to 40° C., elevation of the pulse to 120, and respirations to 30. There was no cough, sputum or pain in the chest. The lungs showed medium coarse rales at both bases with a few areas of bronchovesicular breathing and modification of the voice sounds. The impression was hypostatic pneumonia. On the fifth day following operation the patient was again practically normal and convalescence was uneventful from this time on. He was discharged in good condition on May 26, 1929.

The patient was evidently a poor risk. It is almost impossible to prevent hypostatic congestion in cases of this kind. We believe that hyperventilation is especially indicated in such individuals who must have a diminished vital capacity.

These cases are selected from the series to illustrate the fact that spinal anæsthesia is no more certain of freedom from pulmonary complications than any other form of anæsthesia. There were seven other cases with pulmonary involvement post-operatively, but it was in markedly handicapped patients or supplementary inhalation anæsthesia had been used. In any series of cases there will always be a group which is unfavorable for anæsthesia. These patients will include those with already existing lung pathology; those with septic foci or thrombosed areas from which emboli may be set free; and those who from organic disease present a diminished vital capacity. It is from these conditions that the post-operative pulmonary complications arise. We believe from this study that in an unselected group of patients the incidence of post-operative pulmonary complications is just as high after spinal as after other forms of anæsthesia.

We agree that there is much less post-operative minor discomfort following spinal anæsthesia. This applies particularly to nausea, vomiting, gas pains and distention. Patients do not usually have prolonged periods of nausea and vomiting such as one occasionally sees after ether or nitrous oxide. When vomiting does occur with spinal anæsthesia it takes place either on the operating table or only during the first day after operation. The vomiting during operation is associated with a fall in blood pressure and is really a manifestation of syncope. The post-operative vomiting may represent a disturbed gastro-intestinal nervous balance. Gas pains and distention are less prominent in the convalescence than after inhalation anæsthesia. It is our impression that the patients are in general more comfortable in the first few post-operative days. Occasionally, however, one sees a rather stubborn distention and we feel that when distention does occur it is apt to persist longer than after other anæsthetics. We quote a few case histories to support these statements.

CASE No. 21603.—An obese man, forty years of age, was admitted on February 6, 1929, because of chronic cholecystitis and cholelithiasis. He had a chronic pharyngitis

and a slightly enlarged heart. A thickened inflamed gall-bladder full of stones was removed under spinal anæsthesia. Anæsthesia was perfect, but about 20 minutes after induction of the anæsthesia there was pylorospasm, nausea and vomiting. The vomiting came in two intervals and lasted three minutes each time. The day following operation he vomited considerably and there was marked distention for six days after operation. He was discharged well on March 2, 1929.

CASE No. 2380.—A colored man, twenty-six years of age, was admitted on October 21, 1929. He had been studied previously because of a dull aching pain in the right lower quadrant and a high fever. Typhoid fever had been definitely ruled out and he entered the hospital this time for another attack of pain in the right side. Tuberculous peritonitis or some mechanical obstruction in appendix region were considered. Operation was performed under spinal anæsthesia. A marked Jackson's veil and pericolitis was found. The appendix was removed. Following operation he suffered for six days with gas pains and distention. Enemas failed to give much relief. After the sixth day convalescence was uneventful.

CASE No. 22220.—A man, seventy-two years of age, was admitted on February 27, 1929, because of an incarcerated ventral hernia. He had cardiac hypertrophy with irregularities in rhythm and extrasystoles. There was moderate hypertension as manifested by a blood pressure of 152 systolic and 74 diastolic. The nonprotein nitrogen was 60 grams per 100 cubic-centimetres on admission. The hernia was repaired and a portion of the strangulated omentum was removed under spinal anæsthesia. For five days following operation there was marked distention which then subsided. There were no further complications and he was discharged in good condition on March 20, 1929.

There are other minor discomforts which fortunately are not common, as they are exceedingly annoying to the patient and a cause of worry to the doctor. Throbbing headache<sup>8</sup> which lasts for several days to over a week has been noted on several occasions. We believe the possibilities of spinal fluid leak and consequent low tension of the cerebro-spinal fluid have been removed by the recent advances in technic. We feel that these headaches are due to a lowering of the blood pressure, as it has been evident in our patients. It is very difficult to restore the normal balance quickly although therapeutic measures be directed toward that end. Tinnitus, dizziness and blurring of vision have been noted as accompaniments of the headaches. Complete examination of the eyes and ears has failed to show any abnormality. One of our patients could not read large print for over a week. There are many reports in the literature on diplopia and temporary paralysis of the sixth nerve.<sup>9, 10, 11, 12, 13, 14</sup> We have seen this condition only once in our series. Complications such as these make the doctor rather reluctant to use spinal anæsthesia promiscuously without definite indications.

CASE No. 27973.—An obese woman, forty-nine years of age, was admitted September 16, 1929, for repair of a post-operative ventral hernia. Her heart, lungs and kidneys were normal. Her blood pressure was 90 systolic and 50 diastolic.

Repair of the hernia was carried out under spinal anæsthesia. Anæsthesia was excellent to the level of clavicles. During the operation the blood pressure remained about 70 systolic and 50 diastolic. After operation she had a throbbing headache with crushing sensation through temporal regions. This lasted for three days. She was kept in the Trendelenberg position and given ephedrine and symptomatic treatment. She was symptom free after the third day and was discharged in good condition on October 13, 1929.

CASE No. 7908.—A woman, thirty years of age, was admitted September 19, 1929. She had been under treatment for active pulmonary tuberculosis of both lungs for two years. She had had acute recurring attacks of pain in the right lower quadrant associated with nausea, vomiting and fever. The attacks came about every six weeks. Her present attack began about one week ago and there was still localized tenderness over McBurney's point. She was explored under spinal anæsthesia which did not reach the proper level and had to be supplemented with procaine and a little nitrous oxide. A retrocecal apparently normal looking appendix was removed. There was no evidence of tuberculosis of the ileum, pelvic organs, peritoneum or mesenteric glands. Pathological examination of the appendix showed several small tubercles within its lumen. For the first two days after operation there was considerable nausea and moderate distention. She also had a rather severe headache, photophobia, and tinnitus. The headache was relieved somewhat by the prone position, but it lasted for three days. Tinnitus disappeared on the second day after operation. The course was uneventful after the third day and she was discharged in excellent condition on October 7, 1929.

CASE No. 29022.—A girl, twenty years of age, was admitted on October 24, 1929. She had had recurring attacks of pain in the right lower quadrant. Diagnosis rested between appendicitis and tabes mesenterica. Spinal anæsthesia (spinocaine 200 milligrams), was given, but the anæsthesia did not reach the proper level. After waiting fifteen minutes spinal anæsthesia with the same dosage was repeated. Perfect anæsthesia was secured to the costal margin with no evident disturbance of the patient. A subsiding acute appendix was removed. The following day she complained of throbbing, compressing headache in both temporal regions whenever the head was raised. She also had slight stiffness of the neck, tinnitus, dizziness, nausea and vomiting. There was a complaint of heaviness, dry feeling, and blurring of vision, but no diplopia. Examination of the eyes was negative. Gas pains and distention were present for three days, easily relieved by enemas. The throbbing headaches persisted for eleven days, requiring aspirin and pyramidon for symptomatic relief. Patient was kept in the dark in slight Trendelenberg position and given ephedrine for the low blood pressure (98 systolic, 60 diastolic) which was present. Her normal blood pressure registered 118 systolic, 80 diastolic. She cleared up on the twelfth day and was discharged relieved on November 7, 1929.

CASE No. 27409.—A man, forty-nine years of age, was admitted on August 23, 1929. Three years previously he had had resection of an adenocarcinoma from the transverse colon. He entered this time with an apparent recurrent mass which was freely moveable. There was a quite marked secondary anæmia. Exploration under spinal anæsthesia showed that there was invasion of the abdominal muscles and extensive involvement, making operative removal impossible. The day following operation he complained of inability to see objects clearly. Examination of the eyes was negative. He was nauseated and vomited the next morning and vision remained impaired. He could not read large print even at close range for one week. After that time his vision returned to normal. His wound healed well and he was discharged from the hospital unimproved.

Spinal anæsthesia does not seem to upset the normal kidneys in any way that we can demonstrate clinically. In our experience it has not been responsible for any abnormal constituents in the urine. Tests for kidney function show that there is no impairment after this form of anæsthesia.

In the same way there does not seem to be any effect on the normal heart and blood vessels, lungs or nervous system.

In the abnormal heart, especially when associated with marked hypertension, we consider spinal anæsthesia dangerous. Administration of ephedrine causes an already over functioning system to work harder still. On the other hand, if you omit it, the sudden fall in blood pressure which is almost

invariable with spinal anæsthesia, should never be regarded lightly in hypertensive states. This sudden drop may be associated with unconsciousness<sup>15</sup> from anæmia of the brain; or pulmonary stasis and congestion with thrombosis of terminal vessels; and with failure of function of vital structures. The kidney secretion may be regulated for a high pressure and there may be failure to secrete urine at the lower level from which it is impossible to bring back the blood pressure. We feel confident that this happened in one of our cases here summarized.

CASE No. 22343.—A man, sixty-nine years of age, was admitted on February 26, 1929. He had generalized arteriosclerosis, hypertensive heart disease, and a blood pressure which varied for 190 to 210 systolic and 118 to 140 diastolic. He entered because of an acute attack of pain in the right upper quadrant associated with vomiting and distention. Opinions varied as to whether the condition was due to acute cholecystitis or intestinal obstruction. His white blood count was 26,000 on admission and his urine showed marked albumin and many cellular and granular casts as well as a few red and white blood cells. Operation was performed under spinal anæsthesia the needle being introduced into the first lumbar space with the patient sitting up. This was done because it was not possible to get through the spine in the lateral prone position. Patient was put at once in Trendelenberg position. There was no immediate reaction. About five minutes later the patient became pulseless and the blood pressure could not be obtained. He reacted somewhat after intravenous adrenalin and another subcutaneous dose of ephedrine. An acute cholecystitis with cholelithiasis was found and simple drainage of the gall-bladder was done. His condition on return to the division was poor. The pulse was weak and thready, the extremities cold and clammy. His condition was somewhat better the next day, but he was nauseated, vomited, and had hiccoughs. On the evening of the second day after operation he became very drowsy. He had passed only ninety cubic-centimetres of urine which showed much albumin and many casts. He passed into a uræmic state, being in a comatose condition most of the time, but occasionally rousing up and appearing quite rational. He did not put out any urine although fluid intake was kept up well. The blood chemistry showed a nonprotein nitrogen of 100 milligrams and a creatinine of seven milligrams. The blood pressure was recorded from 125-130 systolic and 75-80 diastolic. Attempts to raise it by routine ephedrine medication resulted in only a slight increase to 135 systolic, 85 diastolic. On the third post-operative day, he developed a mild Cheyne-Stokes type of respiration and quick jerky movements in his hands and feet. He became more and more difficult to arouse and his responses were irrational when he was conscious. He remained anuric. Catheterized urine consisted in only 125 cubic-centimetres which was heavy with albumin and showed many casts. Condition remained unchanged on the fourth day and he died in uremic coma five days after operation. Blood chemistry the day of death showed a nonprotein nitrogen of ninety milligrams; creatinine of twelve milligrams and CO<sub>2</sub> combining power of 24.5 per cent. At autopsy the main findings were generalized arteriosclerosis, coronary sclerosis with occlusion, cardiac dilatation, infarction of the myocardium and practically normal kidneys.

In our experience ether is the anæsthetic of choice for all forms of heart disease whether due to valvular defects, irregularities in rhythm or hypertension.

In cases of hypotension when not due to some debilitating condition, spinal anæsthesia can be used safely. The pressure can be supported with ephedrine. The chance of persistent headache, however, must be borne in mind.

Foreign reports emphasize the danger of spinal anæsthesia when there is an inherent defect in the central nervous system. Special stress is put on the dangers of bringing out neurological manifestations in syphilitics who have shown no such symptoms previously. Such conditions as hemiplegia, myelitis, meningitis, meningeal irritation and optic atrophy have been noted.<sup>16, 17, 18, 19, 20</sup>

We cite a case in which such a possibility must be considered. Perhaps in this instance the failure of the caudal anæsthesia represented injection into the spinal fluid instead of into the extradural space.

CASE No. 14883.—A forty-six-year-old man was admitted on April 21, 1928, for a punch operation because of hypertrophy of the median bar of the prostate. Caudal anæsthesia with twenty cubic centimetres of three per cent. novocain was attempted, but was not successful. Nitrous oxide anæsthesia was used and the operation completed. The patient was irrational on return from the operating room, and shortly afterwards had opisthotonus and marked twitchings of all the muscles. Stimulants were given without effect and death occurred two and one-half hours after operation. Autopsy showed chronic meningitis, ? syphilitic. Nothing else was found to account for the sudden death. The question of novocain poisoning was raised.

As far as we know there is no disturbance in the general metabolism following spinal anæsthèsia. This and the sparing of the kidneys makes it an ideal anæsthesia for diabetes when not associated with marked hypertension. The time of operation can be so spaced between meals that there is no interruption in the routine diet or insulin therapy either before or after operation. This results in the minimum of disturbance in these individuals.

Technically, the abdominal operation is made much easier for the surgeon. The relaxation of the abdominal wall and the contraction of the intestines make exposure a simple matter. These features render spinal anæsthesia almost ideal for such operations as ventral hernias in obese patients, cholecystitis, pelvic conditions, carcinomas of the large bowel and early intestinal obstruction. Gastric resections can be carried out with less difficulty supplementing with a little nitrous oxide if necessary. The surgeon does not need to worry about distended loops of bowel pushing out of the wound. It is easily possible to retract the wall so that direct vision can be used in exploring the abdomen. Closure is made without effort.

Everyone who uses spinal anæsthesia notes that there is violent spasm of the stomach and intestines. For this reason, personally we would never select this anæsthesia in case of any visceral perforation; in any acute peritonitis or localized abscess; or in any strangulation. The danger of spreading infection and peritonitis is too apparent; the danger of rupture of strangulated bowel is too real. This is also the expressed sentiment of the French surgeons who have made a very elaborate combined study of the use of spinal anæsthesia for intestinal obstruction.<sup>21</sup>

We would also never use it in any questionable lesion about the pylorus or duodenum. It is doubtful if one could tell whether a real pathological

process were present in cases not associated with chronic ulceration. The pathological picture is masked by spasm. We quote a case in point.

CASE No. 23660.—A man, forty-three years of age, was admitted on April 11, 1929, because of epigastric pain and a post-operative ventral hernia near an appendectomy incision. No definite evidence of a pathological process in the epigastrium was obtained after study except that there was irritation and irregularity of the duodenal cap. Exploration under spinal anæsthesia was decided upon. Exploration was easily carried out and nothing abnormal revealed except adhesions of the large bowel and omentum to the hernial sac. These were released and repair of the hernia made. He was markedly distended for four or five days after operation. He was discharged symptom free on May 5, 1929. Since discharge there has been a return of the epigastric symptoms.

The surgeon is his own anæsthetist, but the condition of the patient requires expert supervision. In our experience it is well to have the patients carefully observed even under local anæsthesia. We would consider it quite a risk to leave patients after the use of spinal anæsthesia without this observation.

We see no reason for ever employing this anæsthesia for surgery above the diaphragm. There is no difficulty in getting a high level. It is often difficult to prevent this. We consider such a practice equivalent to "stunting" in an aeroplane. Certainly no technical advantage can be offered as a reason and the dangers offset the supposed advantages. Thoracic surgery can best be carried out by local anæsthesia and nerve blocking. Surgery of the head and neck can in our opinion be cared for more safely by other forms of anæsthesia such as colonic ether, tribromethylalcohol, scopolomine-morphine, novocain, etc.

The consensus of foreign opinion is that spinal anæsthesia should never be used in any case of marked anæmia, cachexia, intoxication, general sepsis or debilitating illness, associated with hypotension.<sup>21, 22, 23, 24</sup> The fall in blood pressure in such cases is more than the individual can stand and recovery from the fall is not usual. Our own experience coincides with these statements.

CASE No. 21847.—A man, fifty-four years of age, was admitted on February 16, 1929. He had moderate diabetes, cardio-renal disease, and diabetic gangrene of the left foot. A mid-calf amputation was done under spinal anæsthesia without incident. Twenty-four hours later gas gangrene had developed in the stump. The patient was in very poor condition at this time. He had a rapid pulse—140, and a very low blood pressure. Immediate operation under spinal anæsthesia was carried out. A mid-thigh amputation was done. The patient died shortly after the conclusion of the operation. This is an excellent example of poor surgical judgment.

There is one further indication for the use of spinal anæsthesia, namely as treatment for paralytic ileus.<sup>25, 26</sup> We have employed spinal anæsthesia for this purpose and our results have been variable. Sometimes the relief afforded is striking; at other times nothing seems to be accomplished. We are attempting to separate out the type of case which is benefited. At the present time it seems to us that this form of treatment is useful for typical paralytic ileus not associated with infection, or mechanical obstruction. When

there is a definite obstruction present spinal anæsthesia should be used only as a preliminary to operation. In cases seen after abdominal, pelvic or kidney operations; or after injuries to the spine or ribs, the results seem to justify a trial. It is not always successful. We have not been successful in our treatment of ileus following peritonitis and believe that it carries a decided danger with it. Three cases are cited to illustrate these statements.

CASE No. 22799.—A forty-two-year-old woman was admitted on March 22, 1929, two days after a complicated obstetrical instrumental delivery. On the day of admission the abdomen became tremendously distended and the patient had some nausea and vomiting. There was no evidence of peritonitis. The condition could not be relieved by the ordinary measures, but became progressively worse. It was decided to try spinal anæsthesia the next day after all other treatments had failed. Thirty minutes after spinal anæsthesia, with 150 milligrams of spinocaine, there was decided improvement. The abdomen became softer and flatus was passed freely. Enemas were effective. Distention gradually subsided with complete relief of the paralytic bowel.

CASE No. 22508.—A thirty-nine-year-old man was admitted on March 10, 1929, for an acute intestinal obstruction. Obstruction had been complete for at least ten hours. Under spinal anæsthesia a twisted loop of small bowel was freed from an adhesion to the old scar of an appendix operation. Following operation paralytic ileus developed in spite of vigorous treatment so that no relief was obtained for ten days. On the tenth day an enterostomy was done under local anæsthesia. After this operation slow improvement took place and in three days patient was out of danger. Convalescence from then on was uneventful. He was discharged well on April 7, 1929.

CASE No. 20563.—A boy nineteen years old was admitted on December 23, 1928, with generalized peritonitis due to a perforated appendicitis forty-eight hours previously. He was very toxic. Appendectomy with drainage was done under nitrous oxide anæsthesia. The next day he had pneumonia of the right lower lobe and intense tympanites. His condition became steadily worse and the distention could not be relieved. On the third day after operation he was having so much embarrassment of the respiration because of the distention that it was decided to give a spinal anæsthesia in the hope of relief. This was done with 150 milligrams of novocain with no result. The patient died a short time later.

#### SUMMARY

From reports in the literature and as a result of our own studies we conclude that spinal anæsthesia is especially useful in the following:

- 1 For technical advantages—especially in gall-bladder and pelvic operations; in non-inflammatory conditions of the stomach and intestines, in early intestinal obstruction; in obese individuals with ventral hernias (these patients take inhalation anæsthesia poorly).

- 2 For major surgery in diabetes—because there is no disturbance in routine treatment and a sparing of the kidneys and general metabolism.

- 3 For major surgery of the extremities.

- 4 For abdominal surgery in the presence of active or arrested pulmonary tuberculosis. If marked hypotension is present other forms of anæsthesia should be selected.

- 5 To avoid a certain amount of post-operative discomfort especially nausea, vomiting, gas pains and distention.

- 6 As a treatment for paralytic ileus not associated with inflammation or mechanical block.



We also believe that spinal anæsthesia should not be used in the following conditions:

- 1 Marked sepsis.
- 2 Perforations of viscera.
- 3 Peritonitis or localized intra-abdominal abscess.
- 4 General cachectic states associated with hypotension.
- 5 Marked hypertension.

6 For simple procedures which can equally well be carried out more safely under novocain or epidural anæsthesia. This includes hernias, hæmorrhoids, perineal or anal operations, cystoscopies, etc.

- 7 Paralytic ileus associated with peritonitis.

In conclusion, we believe that there are certain definite indications for spinal anæsthesia. Under these conditions it is the anæsthesia of choice. There are still circumstances connected with the use of spinal anæsthesia which make it a method not devoid of serious consequences. For this reason it should not be advocated in a haphazard fashion, but should only be used when there is a real indication for it.

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# SPINAL ANÆSTHESIA IN MAJOR SURGERY

BASED ON A STUDY OF 1000 CASES\*

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ALTHOUGH accustomed to using spinal anæsthesia for feeble persons, extensive cases of malignancy or the removal of prostate glands from elderly men, it did seem rather radical to introduce a foreign substance into the spinal canal in uncomplicated cases of abdominal pathology such as appendicitis or cholecystitis and it was not until we had personally observed its unrestricted use by Pitkin, Sise and others that our natural reluctance was overcome. The published reports of large series of such anæsthesias by Tuffier, Bier, Babcock, Labat and others further confirmed our inclination to use it in a wider field of operative work. So that now, after an experience in over one thousand cases, we feel that its institution marks one of the most outstanding contributions to the development of surgery both from the standpoint of the surgeon as well as the patient.

Several factors have made possible the introduction of spinal anæsthesia instead of inhalation anæsthesia in routine major surgery. The years of scientific study and investigation carried on by the early workers in this field have been important. However, it is doubtful if this method would have come into general use had not Chen, a Chinese student, at the University of Wisconsin, rediscovered an old Chinese drug known as ephedrine. Ockerblad and Dillon, in 1927, showed that with this drug it was possible to control the fall of blood pressure when used in conjunction with spinal anæsthesia. If properly administered before the anæsthesia is begun, the vascular tone of the body will be maintained until the operation is completed.

Pitkin developed a light and a heavy solution, the former containing alcohol in addition to the novocain in order to obtain a lighter specific gravity than the spinal fluid, the latter containing glucose. This preparation he termed spinocain. He cautioned its users, however, that the method should not be taken up without careful study of the mechanism involved, and that a certain percentage of failures might be expected until the technic was mastered. This method was introduced into our clinic, developed and perfected by Ewell and Stout, as our early experience with spinocain did not prove as successful as its subsequent elaboration. It was necessary in about twenty-five per cent. of the cases to complete the operation under inhalation anæsthesia. Early failures, due to a lack of proper knowledge and technic were to be expected, however, the method which we use at present is successful in practically 100 per cent. of the cases.

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\* Presented to the Association of Resident and Ex-Resident Physicians of The Mayo Clinic, October 10, 1929.

During the past year spinal anæsthesia has been used by us routinely in all major operations below the diaphragm, and in some minor procedures such as cystoscopy. Although Jonnesco, Koster and others have operated on the mastoid, thyroid and cervical glands under this method, these operations have not been attempted at our clinic, nor do I see any indication for such procedures. A superficial nerve block anæsthesia which combined with so-called twilight sleep, makes a very simple and yet nearly perfect anæsthesia for operations on the thyroid gland. Scopolamin has been regarded with the same fear as spinal anæsthesia by some, but this drug has been used daily for more than a decade by members of our staff with no unfavorable results.

Labat has probably done more than anyone in this country to develop regional and spinal anæsthesia. Nevertheless, our experience would lead us to disagree with him in his statement that spinal anæsthesia should not be used in gastrointestinal perforations or localized peritonitis, in which he maintains that in intestinal perforations the contents of the bowel would be milked out as a result of contracted bowels and hyperperistalsis, and that localized peritonitis would be spread for the same reason. However, the first time spinal anæsthesia was used in a perforated duodenal ulcer in a middle-aged man who was in profound shock and suffering severe peritoneal pain, there was immediate relief of the pain from the anæsthesia even before the operation was begun. When the abdomen was opened the intestines appeared contracted and quiet. The convalescence was not only uneventful, but was largely devoid of the shock which would have resulted from inhalation anæsthesia. This has continued to be our experience particularly in cases of gangrenous and ruptured appendices and gall-bladders. Primarily the patient is first of all freed from all cerebral shock because the sensation of pain is eliminated, and the fear of becoming unconscious, as well as the disagreeable awakening with its obnoxious nausea and vomiting also are eliminated.

During the operation the intestines are quiescent and drop back so that frequently one is able to take out the appendix without packing away or handling the bowels. Instead of having to push back and control distended loops of the intestine, one can work swiftly and easily in a quiet field, and it is quite reassuring to be able to remove a gangrenous or ruptured appendix while still conversing with the patient. The peritoneum is so relaxed that closure of the wound is greatly facilitated. I believe I am conservative in saying that this method has made surgery twenty-five per cent. simpler and that post-operative pneumonia, phlebitis, embolism, obstruction and other surgical complications have been reduced to a fraction of that observed with any form of general anæsthesia.

Long major operations under ether and nitrous oxide often sapped the patient's vitality, and he was taken to his room in a semicomatous condition of shock which frequently lasted for hours, awakening with severe retching and vomiting which often weakened his wound as well as himself. What a contrast as we enter the sickroom now. Contrast with this the patient lying quietly in bed, perhaps conversing with relatives or asking nurses about the events of the day, able to take liquids and devoid of pain and nausea.

Our experience, as well as that of other surgeons who are using this method, is now sufficiently large to convince us that this is not just a fad about which a few men are enthusiastic. We feel at our clinic that inhalation anæsthesia should not be used except for certain minor operations or for major operations about the head. For other types of surgery we depend on spinal or regional nerve block anæsthesia. The final question that every surgeon must ask himself before applying any procedure to his patient is, would he use this method on the members of his own family? We have done this and they prefer it to general anæsthesia. A similar answer has been given by ninety-five per cent. of the patients in this series who have answered letters of inquiry. Five per cent. preferred to be asleep, but we believe that the development of the newer sedatives, together with the use of pantopon and scopolamin, will eliminate this small percentage in our next group.

*Contraindications and Complications.*—There is great danger if improper technic is used, but we believe, when correctly used that this method is absolutely safe. There were no fatalities in this group of 1,000 cases that could in any way be traceable to the spinal anæsthesia. There appeared to be no contraindications with the exception of a cerebral neoplasm. Cases of hypotension may be properly controlled by the judicious use of ephedrine.

Early in this series a number of post-operative headaches occurred, a few of which were rather severe for a few days. These headaches were similar to the type, which in past years followed a spinal puncture, and were apparently due to trauma from using a large gauge needle. The use of a 22-gauge needle has practically eliminated this complication. Moderate and marked abdominal distension likewise occurred in a number of patients early in the series. This distention has been obviated or decreased by a more careful preoperative preparation and by the use of pituitrin and Mayo enemas postoperatively. The incidence of phlebitis was 0.1 per cent. and there were no cases of post-operative embolism, by far the best record ever made by the hospital. Post-operative pneumonia occurred in only one case, in spite of a mild recurrence of the epidemic of influenza last winter. It was necessary to operate for acute abdominal lesions on a number of patients suffering from nose and throat infections; the use of spinal anæsthesia obviated any pulmonary complications. Temporary paresthesia occurred in four cases, but a permanent disability or lesion was not present in any case. The prophylactic administration of ten grains of sodium barbital by mouth one and one-half hours preoperatively will apparently eliminate the occurrence of convulsions due to the injection of novocain into the venous plexuses around the cord. As I have previously stated, the prophylactic use of ephedrine will check the tendency of the fall in blood pressure and the nausea and vomiting that may accompany it. Catherization of patients is less frequent because they are able to take fluids before, during and after the operation.

*Technic.*—It is impossible in this short paper to cover the technic which was worked out by Stout. Anyone who is particularly interested is referred

to a series of articles written by Stout and Ewell on this subject. I shall only mention the preliminary medication consisting of 10 grains of sodium barbital,  $1/3$  grain of pantopon which may be repeated, if necessary, and  $1/150$  grain of scopolamin. The volumes of novocain and spinal fluid solution and ephedrine dosage are increased proportionately for large individuals and decreased for small ones. Ephedrine dosage is varied in cases of hypertension and hypotension. Novocain should not be injected for five or more minutes after the injection of ephedrine. Blood pressure readings are taken at frequent intervals by a competent anæsthetist. Ephedrine sulphate in ampules containing  $3/4$  grain in 1 cubic centimetre solution (Lilly) and novocain crystals in ampules containing 100 or 200 milligrams (Metz) were used in this series. Luer-Lok two cubic centimetres and three cubic centimetre syringes and B-D Erusto 22-gauge spinal puncture needles with  $45^\circ$  bevel point are recommended.

*Conclusions.*—Spinal anæsthesia, when properly administered, offers the safest anæsthetic from the standpoint of the patient and the most ideal one for the comfort of the surgeon.

The disagreeable and frequently serious post-operative sequellæ such as pneumonia, embolism, ileus, gastric dilatation and cardiorenal-vascular complications attendant upon the use of inhalation anæsthesia are materially reduced.

The technical difficulties of operating particularly in cases of acute intestinal obstruction are greatly simplified. There is such relaxation of the peritoneum and other structures that the field of exposure is not only improved, but the closure of the wound is facilitated.

The prophylactic administration of ephedrine as a means of governing the blood pressure has been the most important factor in making this anæsthetic popular.

One thousand surgical operations in which spinal anæsthesia was used are shown in Table I.

TABLE I

*Analysis of 1,000 Operations Performed under Spinal Anæsthesia*

Appendectomies . . . . .	238
Cholecystectomies . . . . .	125
Perineal and rectal operations . . . . .	118
Cystoscopic exams. . . . .	100
Pelvic laparotomies . . . . .	83
Hernias (all types) . . . . .	57
Gastro and Duodenal resec. . . . .	52
Orthopedic (leg, hip, spine, etc.) . . . . .	48
Cystoscopies and prostatectomies . . . . .	37
Radical breast amputations . . . . .	12
Miscellaneous . . . . .	130

1,000

TABLE II .

*Complications of Spinal Anæsthesia*

Pneumonia (aspiration) . . . . .	1
Phlebitis . . . . .	1
Mild distention . . . . .	25
Headaches . . . . .	15
Needles broken—removed . . . . .	2
Transient paresthesia . . . . .	4

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# THE TREATMENT OF GAS GANGRENE WITH NORMAL HORSE SERUM

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FOUR cases of severe gas gangrene came under our observation from 1925 to 1928. Antitoxic serum was not available at this time in our city. In a similar emergency during the last war good results were noticed from the administration of normal horse serum in toxic bacillary Dysentery and Paratyphus A. This induced us to try it in our cases of gas gangrene. The results suggested favorable effect of the intravenous injection of normal horse serum. Early this year we made an experimental study on the action of normal horse serum on bacillus Welchii toxin as compared with specific antitoxin serum. These studies are submitted in the following paper.

## CASE REPORTS

CASE I.—S. F. C., a well-built white male of twenty-nine years, was driving a truck loaded with hay on the morning of December 8, 1925. While going downhill the brakes failed to hold and the truck turned over, pinning him to the ground. He was released about an hour later. His left leg was badly bruised and lacerated about the knee. The lacerations were sutured and dressed in a hospital nearby, and the patient was transferred to our institution the following evening (December 9, 1925). He was admitted with a temperature of 103, pulse 140, very weak and drowsy and delirious. The left foot and leg were mottled in appearance. There was loss of sensation to pin prick, extending up to the knee, and no palpable arterial pulsation below the knee. The other physical findings and the previous history of the patient were essentially negative.

The next morning (December 10, 1925) a thorough exploration was made. The leg was cleaned and some gauze wicks, that had been inserted for drainage, were removed. A bloody serum bubbled through the opening, showing the presence of gas, and a penetrating odor escaped from the wound. On removal of the sutures an opening two inches long, leading directly into the inner side of the knee joint was found, with a small area of bone torn out of the articular edge of the tibia. The muscles about the knee joint, the lower part of the thigh and the upper part of the leg were partially gangrenous and, in areas, shredded by the crushing.

*Treatment.*—The soft tissues were widely opened up to the middle of the thigh on the anterior surface and down to the middle of the leg on the inner surface. Large quantities of degenerated muscle tissue were resected. Palpating posteriorly to the knee joint, the artery was found thrombosed just at the point of bifurcation in the popliteal space.

Smears from the depth of the wound showed Gram-positive cocci and Gram-positive square, thick, encapsulated bacilli. Anaërobic cultures and inoculation of guinea pig were positive for bacillus Welchii.

The patient, who previously insisted on saving his leg, gave his consent to an amputation. An enucleation through the knee joint was done under gas anæsthesia, and the devitalized muscle and skin of the stump were trimmed off. Dakin's tubes were inserted for continuous irrigation of the open stump flaps.

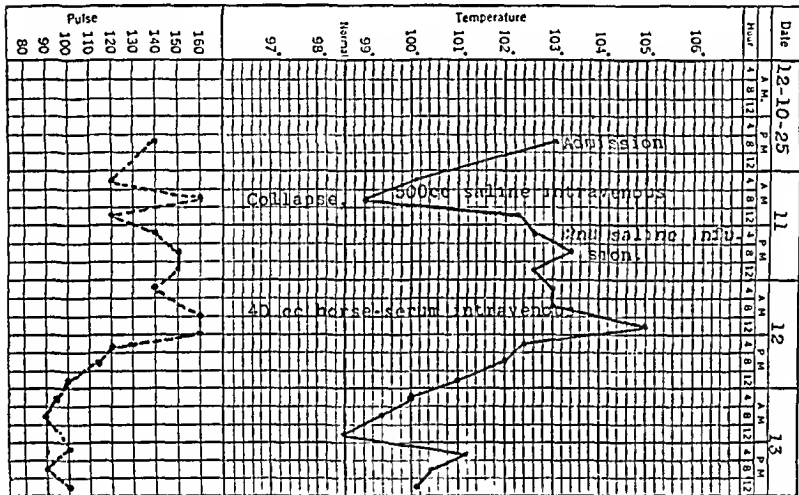
*Progress.*—During the night the status of the patient continued to become more grave, and in the morning of the eleventh the patient was in collapse; the temperature



dropped from 103 to 99, while the pulse rose to 160, and was hardly palpable; respirations were superficial with dilation of the narcs. The face was pale; the patient was restless and in convulsions. An intravenous injection of a pint of saline with fifteen drops of adrenalin, together with hypodermic administrations of 2 cubic centimetres of camphorated oil, improved the condition. The pulse slowed to 120, was fuller; respirations became deeper, sensorium clearer. In the afternoon, however, the toxic condition became again more grave; the temperature rose to 103.4; the sensorium became cloudy. A repetition of the intravenous saline injection had little effect.

At 6:00 P.M. we opened the dressing and found crepitation under a part of the rectus medialis. An incision was made into the muscle; bleeding from a muscle artery had to be controlled by ligature. The wound was lightly covered with gauze and kept under permanent irrigation with 3 per cent. hydrogen peroxide solution. During the night there was a general downward progression and the next morning (December 12, 1925) he was reported as dying.

It was evident that only a strong antitoxic agent could stop the severe toxæmia. Ever since the diagnosis was established we had tried to obtain an antitoxic bacillus Welchii



of serum sickness appeared, and several intercutaneous applications of one-tenth of 1 cubic centimetre of a 1:10 dilution of the serum were negative.

CASE II.—T. F., male, 29 years of age. On June 6, 1926, at 6:00 P.M., patient was putting up a metal screen when the ladder upon which he was standing skidded and threw him into a window. His right arm was severely cut by broken glass. He was taken to a hospital, where the wound was closed by metal clamps, and transferred to our institution.

*Examination.*—June 7, 1926, showed loss of sensation and mobility in all the fingers. The middle, ring and little fingers were contracted in semiflexion and could not be passively extended. It was noted that these fingers were apparently bound down in the upper third of the flexor surface of the forearm, as the skin retracted with each attempt at extension of the fingers. There was a U-shaped laceration extending from about four inches above the wrist joint on the extensor surface, radial aspect, then upward and obliquely across the upper third of the forearm on both the extensor and palmar aspects and then down below the middle of the forearm on the flexor surface. The skin was approximated with metal clamps.

Under general anæsthesia the clamps were removed and the muscles found severely lacerated and torn. Considerable muscle tissue appeared darkened and partially devitalized. All of the sutures in the muscles and tendons were removed and a considerable quantity of devitalized muscle tissue excised. The ulnar and median nerves were found completely severed and the ends retracted, so that they lay separated about two inches. The nerves were approximated and their sheaths sutured. The different tendons and muscles were identified and the ends approximated and sutured. It was necessary to excise considerable skin about the edges of the lacerations, as it was partially devitalized. The patient became considerably shocked and an intravenous injection of salt solution was given while he was on the operating table.

*Progress.*—The next day, June 8, the general condition was grave. The patient had an elevation of temperature to 102, pulse 115, rapid, irregular. He was pale and nauseated and vomited frequently, expelling bile-stained fluids. The stomach was washed, with considerable relief. Salt injections repeated. When the arm was redressed gas escaped from between the sutures. Crepitation was noticed.

*Laboratory Findings.*—Bacillus Welchii positive. A blood transfusion of 500 cubic centimetres was done and 30 cubic centimetres of horse serum and 100 cubic centimetres of salt solution were given intravenously. After the transfusion an amputation through the elbow joint under general anæsthesia of gas and ether was done. The patient's condition was fairly good after the operation. During the next twelve hours the temperature rose to 104.6 and then dropped to 101 in the following eight hours, pulse 90, respirations 18; sensorium was free; he perspired freely. The secretion of the wound diminished; bacillus Welchii disappeared. On the 24th the temperature was normal, the wound bacteriologically clean, and the revision of the amputation stump could be made. Healing occurred without complication.

CASE III.—W. C. A., male, age 21 years.

*Injury.*—December 24, 1926, struck by a truck. Calf of left leg badly lacerated. Dorsum of right leg contused. Laceration sutured and torn muscles repaired in a hospital, where he spent five days before his transfer to our institution. Since the second day after the injury the patient had chills and night sweats. The wound was painful and odorous.

*Past History.*—Gonorrhœal and luetic infection two years ago.

*Examination.*—On admission, December 29, 1926, temperature 101, pulse 120. On the calf of the left leg there was a contused, dirty wound four inches in diameter, the centre of which was filled with devitalized skin and muscle. Deep in the muscular tissue two gauze packs were buried. The patient was toxic; the entire foot, leg and thigh swollen and œdematous. X-rays were negative for fracture, but positive for gas.

*Operation.*—The sloughing edges of the open wound were resected. Enormous quantities of devitalized tissue were excised. A guillotine amputation through the knee joint was done. Numerous incisions were made through the skin and fascia of the thigh extending to the hip. Three thousand units of antitoxic horse serum were given; irrigation with Dakin's solution.

*Laboratory Findings.*—Cultures positive for bacillus Welchii and streptococci.

*Progress.*—Thirty cubic centimetres of horse serum in 500 normal saline solution were given intravenously. The condition improved for two days; the temperature went down to 99.4 and the pulse to 104. On January 2 the patient felt severe pain in the thigh. During the night bleeding occurred from a branch of the femoral artery. For this reason a clamp was applied by the physician in charge, but the clamp crushed the vessel and another clamp had to be applied at a higher level. The next morning the condition was grave; leucocytes 18,900, erythrocytes 3,100,000, hæmoglobin 65. Under general anæsthesia the femoral artery was tied two inches higher and some sloughing muscle tissue was excised. Temperature 102.5, pulse 140; glucose and saline intravenously without any result. Died January 5, 1927.

CASE IV.—D. A., male, age 32 years.

*History.*—February 15, 1928, fell down elevator shaft. Patient was temporarily unconscious; was given first-aid and then transferred to our institution.

*Examination.*—The patient was in shock at the time of admission, showed signs of concussion, vomited and his pulse was 110. He sustained numerous injuries, the most important being as follows: Pain, swelling, crepitus and deformity of the left wrist. On the flexor surface of the forearm, about two inches above the wrist, was a contused puncture wound half an inch long, from which there was considerable bleeding. X-ray examination revealed a severe comminuted fracture of the distal one and one-half inch of the radius. The fragments were badly impacted. There was also a fracture of the ulna two and one-half inches from its distal end.

Examination of the left lower extremity revealed a two-inch contused laceration of the outer side of the thigh about five inches above the knee. Muscle tissue was herniating through the opening and was considerably contused and lacerated. The left knee was badly swollen and the patella tender. X-rays revealed a comminuted fracture of the shaft in the middle third. There was a large segment of bone broken from the distal fragment. The patella was comminutely fractured. *Urine.*—Albumin positive; spermie and pus cells.

February 16, 1928, under general anæsthesia, the left thigh was thoroughly debrided and a saturated solution of iodoform in ether injected. A small drain was inserted. The left wrist was debrided and sutured and the fractures of both wrists reduced and immobilized in yucca board splints. Three thousand units of tetanus antitoxin were given. The temperature was between 98 and 100, pulse between 92 and 120 until February 18. He vomited some dark brown fluids and complained of severe pain in the limbs.

On February 18, 1928, the condition took a critical turn. The patient became very restless and he had severe pain. On examination the skin of the left thigh was found discolored around the laceration. Palpation revealed no gas at that time. Cultures were positive for gas bacilli, Welchii predominating. All sutures were removed from the leg and drainage tubes inserted. Hourly injections of peroxide of hydrogen were ordered.

*Laboratory Findings—Smears—Bacillus Welchii and Œdematicus.*—February 18, examination of the wound on the thigh revealed beginning sloughing of the muscles. Several incisions were made in the thigh and the necrotic muscle excised. Irrigations of hydrogen peroxide continued.

February 19, the patient was restless. He had severe pain in his left knee. Temperature was 101, pulse 132. Palpation revealed gas crepitus in the tissues of the thigh. Very drastic incisions were made in the necrotic areas. It was found that the deep

muscles of the thigh were badly involved. He was given intravenous injections of saline and glucose; was restless and at seven o'clock in the evening coughed up bloody sputum. At ten o'clock he was given 1000 cubic centimetres of glucose, and at 11:30 50 cubic centimetres of horse serum intravenously. The pulse went up to 140 and 160. He was irrational during the night, and died at seven o'clock in the morning of February 20, 1929.

*Clinical Consideration.*—These four cases represent the severest type of gas gangrene. They had suffered compound fractures, with the exception of Case III. The soft tissue wounds were extensive, badly torn and contaminated with dirt. The surgical measures were not adequate; the wounds were closed before admission to our institution and also here the attempt to conserve was carried too far; amputation was delayed. In some cases plastic operations were attempted. The infection and toxæmia was far advanced before we had the opportunity to try the horse serum. These points must be taken into account when we consider the effect of the treatment. Two cases were saved, the other two died. Case IV can be justly excluded; the serum was administered only seven hours before death. In the three other cases the horse serum appeared to have a detoxicating action. (See chart.) The reaction seemed typical; temperature and pulse rose for four to eight hours. After reaching a maximum up to 105 and 140 respectively, they went down to nearly normal. Perspiration set in, the pain diminished and the patient found rest. In two cases this was the turning point to recovery; the wounds cleaned, pus and then granulations were formed. The anaërobic bacilli disappeared from the wound. In Case III the beneficial effect was only transitory. After two days a bleeding occurred from the femoral artery and exhausted the patient.

*Experimental Study.*—In order to establish the mechanism of the detoxication by horse serum in our cases of gas gangrene, we carried out the following investigation: A group of pigeons was injected with horse serum and with perfringens (Welchii) toxin. Another group of pigeons was protected by specific antitoxic serum. Two brands of horse serum were used. The perfringens toxin and the antitoxic serum were supplied by the firms of Parke-Davis, Mulford and Lederle. I wish to express my appreciation and thanks for their kindly and prompt coöperation.

The pigeons were injected, according to the method of Flexner and Bull, into the breast muscle. Series of two and three pigeons were used for each dosis. The protective agent (horse serum or antitoxin) was either injected separately in one breast muscle and the toxin after an hour in the opposite side, or the serum was mixed with the toxin and incubated at 37 centigrades for one hour before the injection. The sera were given either concentrated or diluted with normal saline solution. These modifications did not show any influence on the results, which depended solely on the dosis of toxin and antitoxin applied. Therefore, only one set of experiments is reported here and the controls with modified technic are omitted.

Two brands of Welchii toxin were used. The standardization by the manufacturer was for Brand A—M. L. D.: 0.09 cubic centimetre per 100

grams; for Brand B; 0.5 cubic centimetre M. L. D. for 350 grams pigeon. Our standardization six to eight weeks later gave the following results:

*Brand A.*—Three pigeons injected with 0.2 cubic centimetre per 100 grams; Two alive, one dead in twenty-four hours.

Three pigeons injected with 0.3 cubic centimetre per 100 grams; All dead in six hours.

*Brand B.*—Two pigeons injected with 0.3 cubic centimetre per 100 grams; One dead, one alive.

Two pigeons injected with 0.4 cubic centimetre per 100 grams; Both dead in six hours.

We therefore chose 0.3 cubic centimetre of Brand A and 0.4 cubic centimetre of Brand B per 100 grams, which killed uniformly all pigeons in six hours, as our working lethal dosis. Three brands of specific antitoxic sera were employed to protect against this lethal dosis of Welchii toxin.

The smallest dosis of antitoxin sufficient to save uniformly all pigeons was:

For Brand one and two; 0.01 cubic centimetre per 100 grams.

For Brand three; 0.05 cubic centimetre per 100 grams.

Brand three was designed by the manufacturer as not concentrated. This should account for its lower potency. A summary of the attempts to protect the pigeons by horse serum is given in Table I. Controls and repetitions with the different technique are again omitted.

TABLE I

Effect of Normal Horse Serum on the Lethal Dosis of Bacillus Welchii Toxin (Brand A 0.3 cubic centimetre, Brand B 0.4 cubic centimetre per 100 grams).

Pigeons Injected	c.c. Horse Serum per 100 gms.	Result
3	0.1 c.c.	2 died; 1 survived
4	0.2 c.c.	2 died; 2 survived
3	0.25 c.c.	3 died; 0 survived
2	0.3 c.c.	2 died; 0 survived
2	0.4 c.c.	2 died; 0 survived
3	0.5 c.c.	2 died; 1 survived

*Comment.*—The results were not constant or uniform. A dosis of 0.1 cubic centimetre horse serum per 100 grams saved several pigeons. On the other hand, an increase up to 0.5 cubic centimetre per 100 grams did not protect uniformly all birds from the six-hour lethal dosis of perfringens (Welchii) toxin. These experiments prove that bacillus Welchii toxin is not neutralized by normal horse serum. The detoxicating effect of horse serum in our clinical material appears to be due to a different mechanism. Its action on temperature, pulse and general symptoms (see chart) seems to indicate an unspecific destruction of the toxin, which is thermolabile and very sensitive to change of medium (PH. concentration). We are well aware of the objection that our clinical material is small and therefore not conclusive, but due to the rare occurrence of gas gangrene in civil surgery, larger series of cases cannot be expected. In our institution, which is devoted to industrial surgery, these four cases occurred in more than twenty-five thou-

sand open wounds. This material includes over fifteen hundred fractures. Only for the severest injuries, especially compound fractures of extremities, does the percentage of gas gangrene amount to 3 or 4 per cent.

As to the diagnosis of gas gangrene, the positive finding of gas gangrene bacilli in a wound does not prove the diagnosis unless there is clinical evidence of rapid spread of the process and toxæmia. In a number of our cases bacillus *Welchii*, *œdematiens* and *Vibrio septique* were found in wounds which showed only a localized necrosis and sloughing. The pathological report should also not be made alone on the strength of anaërobic cultures, but animal inoculation is necessary to prove the virulence of the organism. We have the impression that some cases recently reported were not subjected to this rigorous demand. Our cases offered the picture of extensive gas gangrene, with severe toxæmia. The treatment was administered in advanced stage. There was a consensus of opinion of all colleagues connected with the institution as to the favorable effect.

On the other hand, the emergency which prompted the use of normal horse serum is past. Bacillus *Welchii* (*perfringens*) antitoxin is now available, at least in the larger cities. Our experiments have proven the high antitoxic properties of the product. In two brands 0.01 cubic centimetre protected 100 grams of pigeon against an absolute lethal dosis. On this basis 10 cubic centimetres is sufficient for 100 kilo (two hundred pounds) of pigeon, which is more susceptible to the toxins than man. This is a very great progress. The titres of antitoxin given by Bull and Prichett<sup>1</sup> amounted to circa 0.15 to 0.3 cubic centimetre per 100 grams or fifteen to thirty times the above dosis. Henry<sup>2</sup> showed that some antitoxic sera produced during the war had a very low potency. With the concentrated products now available, it appears to be safe to reduce the dosis. Fifty to one hundred cubic centimetres were generally required as effective dosis for treatment of human gas gangrene. This naturally involved the danger of shock and severe allergic reaction. Our experiments suggest that ten to twenty cubic centimetres should now be sufficient. This applies only to infections solely caused by bacillus *Welchii*. Where other anærobes (*bacilli œdematiens*, *Vibrio septique*) are present, a polyvalent serum has to be used. To our knowledge such a serum is not yet on the market. The reason lies in the high cost of production and the small demand. Bacillus *Welchii* antitoxin is used on a broader scale only recently, due to its recommendation by Williams<sup>3</sup> in Intestinal Obstruction and Peritonitis. Other authors are trying its efficiency in pernicious anæmia. Recent experimental studies by Oughterson and Powers<sup>4</sup> and others do not support Williams' claim. This makes its future application problematical. Should its use in obstruction be abandoned, there is danger that the production of the *Welchii* antiserum will again be curtailed and its availability limited. Also in case of war, the number of gas infections increases so rapidly that at some periods the production of specific antisera will lag behind. In such an emergency we feel that the substitution of horse serum is justified.

According to our viewpoint, that the destruction is unspecific and takes place during the reaction, we would suggest a dosis of fifty cubic centimetres in 500 saline administered at intervals of twenty-four hours, dependent on the condition. Where poor general condition and circulatory disturbances force avoiding severer reactions, small dosis (10 cubic centimetres) should be started with and the reaction watched before increase. It is wise to test the patient's sensitiveness against horse serum before the intravenous injections by the intradermal injection of two drops of 1:10 solution of the serum. In case urticaria develops, 2 cubic centimetres are given subcutaneously and the intravenous injection delayed for several hours. We also recommend the use of horse serum which has been stored for several months, because this produces less allergic reactions.

#### SUMMARY

(a) Four cases of severe gas gangrene were treated with normal horse serum. The clinical observations in this material suggest a detoxicating effect.

(b) Horse serum does not neutralize bacillus Welchii toxin, therefore does not protect pigeons against this toxin. Its action is based on unspecific destruction of the toxin.

(c) Commercial brands of bacillus Welchii (perfringens) toxin were found to possess high titre. (0.01 cubic centimetre per 100 grams pigeons sufficient to protect against an absolute lethal dosis of toxin.)

(d) Ten to twenty cubic centimetres of this serum, repeated according to the progress, should therefore be effective against the toxæmia of gas gangrene caused by bacillus Welchii.

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## SYPHILIS AMONG SOUTHERN NEGRO MALES\*

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For several years the two senior authors have had an opportunity to observe and study a comparatively large number of negro male surgical patients in one of the out-patient clinics of the Charity Hospital of Louisiana in New Orleans. This clinic is conducted on alternate days, and the number of patients treated daily has varied between 85 and 125, somewhat more than fifty new cases being usually seen during the course of a week. The age incidence of patients coming under observation is from six years upward. The surgical conditions for which patients seek treatment in this clinic are varied. Possibly the largest group of cases represent ordinary traumatic injuries, such as lacerations, contusions, gun-shot and stab wounds, minor fractures, and head injuries, as well as burns and surgical infections. A relatively smaller number of cases, representing major surgical conditions, are sent to the clinic primarily for diagnosis prior to admission to the wards of the hospital.

As a result of the observation and study of the patients passing through this clinic, we have been impressed with the comparatively large percentage presenting unmistakable clinical evidences of syphilis, and particularly the more spectacular manifestations of the disease, such as large, sloughing leg ulcers, massive cervical adenitis, extensive periostitis, the stigmata of congenital syphilis, and occasionally, aneurysm. Not only have we been impressed with these fairly obvious conditions, but also, as a result of increasing experience, with the fact that many cases presenting atypical histories and physical findings, when subjected to serological examination during the course of routine study, have been found to present a strongly positive complement-fixation test and also to respond rapidly to antiluetic treatment. This has been particularly noticeable in cases of vague abdominal distress, backache, joint and bone pains, and cervical adenitis. In addition to these considerations, the relative frequency with which a history of previous antiluetic treatment has been obtained from these patients during the course of routine history-taking has also been an object of note.

Because of these observations, because of a lack of uniformity of estimations of the incidence of syphilis in the negro as found in the literature, and also because of the suspicion that the incidence of syphilis in this particular locality is unusually high, we have been stimulated to undertake a statistical survey of syphilis as it has come under our observation in the practice of surgery amongst colored charity patients in New Orleans.

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*Method of Study.*—It is, of course, generally recognized that the diagnosis of syphilis depends not only upon the recognition of clinical manifestations of the disease, but also upon a study of the serological reaction. Possibly the tendency in modern times is to place too much reliance upon the serological reaction, and too little upon the clinical manifestations; at least a considerable number of studies purporting to estimate the incidence of lues in groups of clinical cases has failed to take duly into consideration both the clinical and serological aspects of the question. In order that we might make our studies as informative as possible, we have attempted to place no undue emphasis on either the clinical or sero-diagnostic aspects of the disease, but to evaluate and correlate the one with the other.

Obviously such a study as the one contemplated could be of very little value if any method of selection of cases were to be employed. Accordingly, it became necessary to study all of the cases admitted to the clinic during a given period of time, omitting none. Because, however, of the relatively large number of patients requiring treatment in the clinic, and also the somewhat limited amount of time available during clinic hours for the purposes of this investigation, and also because of our unwillingness to slight the clinical scrutiny of any of the cases subjected to study, it became necessary to divide the patients into two groups, one of these consisting of cases which were thoroughly examined both clinically and serologically, and a second group comprising cases which were studied solely from the serological point of view. Naturally, this introduced a minor element of selection into the investigation, but we believe this was of no particular significance inasmuch as the method of procedure consisted of studying completely the new cases which were admitted, while the serological test, in the absence of clinical notations, was applied to such cases as had previously received surgical treatment in the clinic and were returning for a continuation of their treatment. The complete series of patients reported upon in this communication comprises 509 cases. Of these 304 were fully investigated, both from the clinical and serological points of view. The remaining 205 represent cases in which only the serological manifestations of the disease were examined. The complete series represents all the cases seen in this clinic from June 12, 1929 to August 31, 1929.

The clinical study of the 304 cases completely analyzed comprises the following observations:

I. As concerns the clinical history:

- A. The age of the patient.
- B. The social status, whether married or single, and if married, how many times, for how long, the number of children, living and dead, and the number of miscarriages.
- C. Any history of a probably syphilitic primary lesion, together with the time of appearance, character, and duration of such lesion.
- D. The history of any previous serological examination and any probable anti-luetic treatment received.

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- E. History of infection with other venereal diseases—gonorrhœa, chancre, and bubo.
- II. As concerns the physical examination:
  - A. Present evidence of previous primary lesion.
  - B. Evidence of adenopathy, whether epitrochlear, posterior cervical, axillary, or inguinal.
  - C. Cutaneous manifestations, such as rashes, leucoderma, alopecia, gummata, and ulcers.
  - D. Osseous changes, such as periostitis, Charcot's joint, and osteitis.
  - E. Hepatic and splenic enlargement.
  - F. Testicular tumor.
  - G. Neurological manifestations, especially the pupillary reflexes, the patellar reflex, and Romberg's sign.
  - H. Evidences of inherited syphilis, especially saddle-nose, Hutchinson's teeth, and perforated palate.
  - I. Evidence of arteriosclerosis, general cardiovascular disease, and a record of the blood pressure.
- III. As concerns the serological reaction:
  - The Kahn precipitation test.

In addition to the physical examination and the securing of a sample of blood for serological study, and, of course, before any information had been gained from the serological reaction, a statement was recorded, based on the clinical aspects of the case alone, as to whether the case was or was not luetic. In those cases in which a perfectly definite history of previous anti-luetic treatment, or of a previous definite positive blood reaction was obtained, the case was recorded as clinically luetic, even in the absence of definite physical signs. However, in general, purely presumptive evidences of syphilitic infections were disregarded, and the case was not recorded as syphilitic unless it presented definite and typical clinical manifestations.

*Historical: The Incidence of Syphilitic Infection.*—Wassermann, Neisser, and Bruck, in 1906, were the first investigators to utilize the phenomenon of Bordet and Gengou in the serological diagnosis of syphilis. Prior to this date estimations of the incidence of syphilis are of uncertain value, because of a lack of laboratory confirmation of clinical findings. Even for several years subsequent to 1906 the technic of the serodiagnostic reaction was imperfectly understood, and the number of investigators competent to perform reliable serological examinations was small. Consequently, reliable statistics of the incidence of syphilis based on both clinical and serological data are confined to the very modern period comprised by the last twenty years or so.

For fairly obvious reasons the general incidence of syphilis in the population at large cannot be determined with accuracy, but can only be estimated, since selected groups of persons only, can be subjected to examination under the conditions of modern social organization. Such groups as have been studied consist, for the most part, of persons who have voluntarily sought medical attention because of illness, or who, because of the force of circum-

stances, have been placed in a position in which such examination became more or less compulsory. Figures based upon such studies cannot, of course, reliably fix the absolute incidence of syphilis amongst the general population, although they may possibly be assumed to reflect, more or less exactly, comparative or racial incidence, when similar series of cases are available for comparison.

The incidence of syphilitic infection amongst the white population of the United States is unknown except as it can be surmised from a perusal of cases (a) admitted to hospitals of various kinds, (b) studied by physicians from their private records, (c) admitted to penal or other institutions served by physicians, and (d) applying for employment in certain particular capacities, as, for instance, service in the Army and Navy.

J. W. Williams, in his book on Obstetrics, published in 1908, (reviewing 10,000 cases) shows the presence of lues in over 3.5 per cent. of pregnant women between the seventh and ninth months of their pregnancy. He also makes the statement that this figure would probably be increased if cases of earlier pregnancy were included. The exact basis upon which he arrives at his figures is not clear.

Munger<sup>1</sup> compares the incidence of syphilis in Army and Navy recruits. He made a survey of 500 recruits who had less than one week's service in the Navy. In reporting his results positive Wassermann reactions were reported in only two degrees, either as "2+" or "1+". Of the 500 cases he found five with a "2+" reaction, or 1 per cent., and three with a "1+" reaction, or 0.6 per cent. The "2+" reactions were obtained in men over twenty-one years of age, whereas the average age of naval recruits is nineteen years. These findings were obtained at the training station at San Francisco, California. Of 500 army recruits at Fort Slocum, thirty-five showed "2+" Wassermann reactions, which represents 7 per cent.; forty-eight showed a "1+" serological reaction, a percentage of 9.6. Munger estimates that 16 per cent. of men, both in the Army and Navy, ultimately contract the disease.

Walker and Haller<sup>2</sup> report the findings from routine Wassermann examinations of 4,000 hospital patients, distributed as follows: 1,800 cases in medical wards, 350 cases in the neurological division of the surgical service, and 1,850 cases from the outpatient department or in the general surgical service. Of these, 600 gave positive complement-fixation reactions. These 600 cases (or 15 per cent. of the 4,000 cases examined) do not include the occasional cases of neurosyphilis with definite clinical findings, or other cases, such as those of paroxysmal tachycardia which improved under active anti-luetic treatment. Concerning the distribution of the manifestations of syphilis in this group of cases, Walker states that forty-eight cases were in the very early stages of syphilis; thirteen still presented chancres, and thirty-five presented a generalized skin rash; 306 were in the later stages and presented gummata, periostitis, endarteritis, ulcers, and the like; thirteen cases were diagnosed as "congenital"; 120 cases presented lesions of the central nervous system; fifty-four cases showed evidence of aortic disease; ten were afflicted with epilepsy; ten showed disease of the liver, ten disease of the kidney; nine suffered from pneumonia, seven from diabetes, and thirteen from miscellaneous conditions. Of the 120 neurosyphilitics, representing 20 per cent. of the cases, seventy-six were victims of tabes dorsalis, fifteen of general paresis, and twenty-nine of syphilis of the central nervous system. Very few children, and no infants, are included in this series of cases, but in spite of this fact, thirteen cases of congenital lues were seen.

McLester<sup>3</sup> reports the results of 557 consecutive Wassermann reactions performed on private patients, most of whom were derived from the well-to-do classes and all of whom were seen in consultation. In this series the original Wassermann technic was

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used, and ninety-four, or 16.5 per cent., gave a positive serological reaction. Seven patients with a negative Wassermann reaction showed unmistakable evidence of syphilis, thus bringing the total percentage to 17.8. The author feels that these figures fairly represent the incidence of the disease in the better class of patients. Of the ninety-four cases examined, twenty-seven gave a positive history of chancre, *i.e.* 29 per cent.

Parran<sup>4</sup> thinks that the percentage rate of syphilitic infection is of the order of five times as great in urban districts as in rural ones. In cities of 25,000 and over, he finds that 6.74 persons per thousand are under treatment for syphilis, while in rural districts the rate is 1.27 per thousand. Of this number, 38 per cent. are cases which have developed within a period of one year. He estimates that while the total rate in males is 4.85 per cent., the incidence in females is 3.02 per cent.

Kilduffe<sup>5</sup> examined 512 prostitutes serologically for evidence of syphilis. Of these 217, or 42 per cent., presented a positive reaction of one degree or another.

Lai and Lai<sup>6</sup> in a study of 430 Chinese obtained an incidence of syphilis, as shown by the Kahn test, of more than 13 per cent.

With respect to the incidence of syphilis in the American negro, and particularly the relative distribution of the disease between the white and colored population of various sections of the United States, considerably more complete information is available.

Hazen<sup>7</sup> states that 22 per cent. of 2,000 negroes afflicted with venereal disease gave positive Wassermann reactions.

Lynch, McInnes, and McInnes<sup>8</sup> found a 50 to 60 per cent. incidence of syphilis in negroes.

Jamison<sup>9</sup> as a result of examinations conducted in connection with 1,000 consecutive colored medical cases seen between June 1, 1915 and January 1, 1916 in this author's clinic at Charity Hospital, New Orleans, Louisiana, estimates that 166 cases showed positive evidence of lues, this number representing 16.6 per cent. He states, however, that the diagnosis may be open to question, even in the 166 cases, and intimates that the actual incidence of the disease may be somewhat higher. These patients were all females, and Jamison states that only 25 per cent. of them were examined vaginally. He only very rarely found a chancre or the scar of a chancre. Jamison's estimation is perhaps open to criticism, in that his investigation was not satisfactorily controlled serologically; in only eighty-one of 166 cases diagnosed as syphilitic was a complement-fixation test performed. In these cases the reaction was positive sixty-five times and negative sixteen times. He states, however, that the routine performance of the test in 100 cases did not alter the percentage. Jamison found only two cases of aortic regurgitation, two cases of tabes dorsalis, and only one of paresis. In the series no single case of aneurysm was diagnosed, and Jamison believes, therefore, that such clinical manifestations of lues are exceedingly rare in the negro female.

Hindman,<sup>10</sup> reporting statistics from the Georgia Insane Hospital, found 16 per cent. of positive luetics amongst 255 male negroes, and the same percentage in 218 female negroes.

Ivey<sup>11</sup> reporting a study from the Mt. Vernon Insane Asylum of Alabama, found 25 per cent. of 357 male insane negroes syphilitic, and 29 per cent. of 349 female negroes.

Lynch<sup>8</sup> reporting figures from an out-patient clinic in Charleston, S. C., found 7.8 per cent. to show a strongly positive Wassermann reaction.

McNeil<sup>12</sup> reporting on the incidence of syphilis among 1,200 cases of adult negroes fifteen years of age, or older, found 34 per cent. which gave definite positive Wassermann reactions, and in the case of 600 of these patients, in whom both Wassermann and luetin tests were performed, 35 per cent. gave positive Wassermann reactions, while only 18 per cent. gave positive luetin reactions. However, 42 per cent. gave positive reactions to one, or the other, or both tests. In a series of 200 additional cases taken

from a surgical service there was a 24 per cent. incidence of positive serology. Of fifty-two cases from one to twelve years of age, an incidence of 9.5 per cent. was found. Of 400 cases admitted to a medical service with various common diseases 40 per cent. gave a positive reaction—this in contra-distinction to a 34 per cent. incidence in 300 cases taken from a surgical service.

Levin<sup>13</sup> reviewed the results of serological examinations made in the laboratory of the U. S. Army base hospital, Fort Reily, Kansas, on 6,450 white soldiers and 3,039 colored soldiers. Of the former, 680, or 10.5 per cent., gave positive reactions, while of the latter 558, or 18.3 per cent. gave positive reactions. Thus the complement fixation reaction was positive 1.74 times as frequently in the colored soldier as in the white. In arriving at these results the reaction was read in terms of "2+", "1+", and "negative". Only the "2+" was considered diagnostic of syphilis, but cases with a "1+" reaction, who also presented clinical evidence of the disease, are included in the figures.

Royster<sup>14</sup> studied 1,000 children from the point of view of the Wassermann reaction and other manifestations of syphilis. Of the 1,000 cases, 659 were colored and 341 were white children. Of the total number of cases 125 showed positive reactions, and of these 101, or 15.47 per cent., were colored, and twenty-four, or 7.04 per cent., were white. The basis of the selection of cases is not given, but all of the children were ill or ailing.

Belding and Hunter<sup>15</sup> report the results of complement-fixation tests performed on 5,198 maternity cases from the wards of the Robinson Memorial Building, of the Massachusetts Homeopathic Hospital. For the purposes of this report all reactions from "1+" to "4+" were designated as positive. Of these cases 0.2 per cent. showed positive reactions of varying strength; 7.8 per cent. showed from "2+" to "4+" reactions, and 4.6 per cent. showed a "4+" reaction, among the negroes 17.1 per cent. gave a positive reaction, among the Americans, 9.4 per cent., the Irish, 8.5 per cent., the Jews, 7.7 per cent., the British, 6.7 per cent. The lowest figure is given by the Italian race with a percentage of 1.5.

Wenger<sup>16</sup> reports the results of complement-fixation tests by the Wassermann technic on healthy negroes living in the "delta region" of the Mississippi River in Mississippi; 2,304 cases are included, of which 1,247 were males, and 1,047 females. For the entire group, men, women, and children, 23.6 per cent. of the reactions were positive. This included 305 positive cases among the males, and 289 among the females. The basis on which positive reactions were read is not stated. The complement-fixation tests were performed by the Hot Springs Laboratory, and by the State Hygienic Laboratory of Mississippi. Of the 1,257 males examined, 24.3 per cent. showed positive reactions, while of the 1,047 females examined 22.8 per cent. showed positive reactions. In the age group one to 5, there were seventeen persons, only one reaction being found positive. In the group five to nine years there were 204 cases, with seven positive reactions. In the group from ten to fourteen years of age there were 234 cases and twenty-one positives, in the groups from fifteen to nineteen years, 257 cases, with forty-five positives, in the group from twenty to twenty-nine, 541 cases with 181 positives, in the group from thirty to thirty-nine years, 378 with 142 positives, in the group from forty to forty-nine years of age 335 cases with eighty-three positives, and in the group from fifty years upward, 339 cases with sixty-five positives.

Paullin, Davison, and Wood<sup>17</sup> estimated on the basis of serological and clinical investigations, that of 4,766 male and female patients admitted to the medical wards of the Grady Memorial Hospital of Atlanta, 662 or 13.8 per cent. showed definite evidence of syphilis.

*Comment.*—While the results of all these investigations are informative and provide much valuable material for consideration, the methods in com-

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mon use in collecting data of the kind under discussion are not always above criticism.

I. In the first place the standardization of the method of making the clinical diagnosis is often not sufficiently well controlled. The clinical diagnosis has often apparently been taken from hospital records without due regard to the conditions under which the clinical record was obtained, and in the absence of definite evidence to the contrary, it must certainly be assumed that records from different sources will vary considerably, not only with the personal equation, but also with other factors, such as the special interests of the medical attendant responsible for the final diagnosis, the length of the time of observation, and other factors too numerous to mention. Unless patients are examined specifically for the presence of a given disease, and some sort of standardized practice of recording data is adopted much of the value of any statistical study is sacrificed.

II. Serological tests for syphilis are of many grades of sensitivity, and unless the particular technic used, and the method of recording results is specifically stated, much of the scientific value of statistical data is forfeited. It is obviously futile to attempt to compare results obtained from a series of inadequately controlled routine hospital Wassermann reactions with a series of carefully performed reactions which have been checked and rechecked against a number of different antigens, dilutions, amboceptors, and incubation periods, especially if repeated examinations of the blood of the patient have been made.

III. Unless routine examinations of all the members of a group be made, the percentage incidence of any condition in the group cannot, of course, be accurately determined. In the past, patients have frequently been subjected to serological examination only in case there was some reason to suppose the reaction might be positive. Obviously statistics compiled from such a selected group can be of relatively little value as expressing the true condition of the whole. Of late years, of course, the routine serological testing of hospital patients for syphilis has become of much more frequent occurrence than formerly, and consequently the true incidence of lues is becoming more and more apparent.

IV. As with the clinical examination of patients for lues, so with the laboratory diagnosis—unless the serological manipulations are supervised by one scientifically inclined and interested in statistical accuracy, and the method of obtaining and recording these results is duly standardized, one cannot hope to obtain satisfactory precision. The practice of attempting to correlate the findings of relatively disinterested and constantly shifting laboratory personnel with unstandardized clinical results from an equally shifting, if not equally disinterested, professional personnel, makes a combination which is far from satisfactory from the point of view of scientific accuracy.

Any statistical study of the incidence of lues which adequately takes the preceding factors into account should be of value, and, though the series of cases reported in the present communication is not very large, all of the

cases have been examined specifically for the presence of clinical lues by a standard routine and with a comparable degree of accuracy, and the serological reactions have been performed solely for the purposes of the present study and not as a mere matter of routine, no pains having been spared to make both clinical examination and serological reaction as accurate as possible.

*Serological Examination.*—In obtaining serological reactions in connection with this investigation, the Kahn precipitation test has been used exclusively. Some consideration of the reliability of this reaction in the detection of syphilis is therefore in order.

*Reliability of the Kahn Reaction in the Diagnosis of Syphilis.*—The Kahn test had its beginnings in 1921 when Doctor Kahn began to apply the precipitation phenomenon to syphilitic sera. It has been subsequently developed and standardized.

The reliability of the Kahn precipitation reaction, as developed to date, as a method of laboratory diagnosis of syphilis can now be regarded as established. The report of the Second Laboratory Conference on the Serodiagnosis of Syphilis of the League of Nations Health Organization<sup>18</sup> makes clear that the Kahn test is equal in value to the best of those tests which depend on fixation of complement.

In the competition held at Copenhagen, on about 927 sera, the Kahn technic gave no false positives and was surpassed in sensitivity by only one other test, the "Muller-Clotting" test. This latter test, however, gave one false positive. The Kahn was checked against seven different Wassermanns, and in 500 known cases of syphilis gave 305 positive reactions, while only 208 positive reactions were given by the best of the Wassermanns. The published report of the competition seems to give no undue credit to the remarkable reliability of the Kahn reaction.

Of further significance, as attesting the value of the reaction, is, of course, its adoption to the exclusion of all other methods by the Army and Navy medical services, and a steadily increasing number of public and private laboratories throughout the United States.

Many of the critical investigations of the value of the Kahn precipitation reaction which have found their way into the literature in the past few years have taken as their criterion of evaluation, the measure of agreement between the Kahn precipitation reaction and some standard complement-fixation technic, or technics. Obviously such a criterion is far from ideal, since Wassermann reactions at best are capable of showing only an incomplete correlation with clinical manifestations.

Louise Endicott<sup>19</sup> summarizes the results of parallel tests with the Wassermann up until the year 1927. She states that of 265,886 serum tests, 59,703 were positive and 227,366 were negative by the Wassermann reaction, and 63,189 were positive and 226,068 were negative by the Kahn reaction. Complete agreement between Kahn and Wassermann reactions was found in 88.47 per cent., partial agreement in 6.48 per cent., and complete disagreement in 5.04 per cent. The disagreement in various series of investigations ranged from 1 to 21 per cent. Considering the various Wassermann technics used, this disagreement is not surprising. In general it has been found that

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as the technic of the Kahn test has been improved, more and more complete agreement with the Wassermann technic has been found.

With regard to the sensitivity and specificity of the Kahn reaction when checked directly against clinical findings, considerable evidence has now accumulated.

In "primary" syphilis the Kahn test is apparently positive in from 80 to 100 per cent. of cases, and is, accordingly, much more sensitive as a diagnostic test than the older Wassermann reaction.

Elliott and Todd,<sup>20</sup> using the "micro-Kahn" test on the sera of twenty-three cases of chancre, so diagnosed by the "dark field", found a positive Kahn reaction in twenty-one. Kahn and Keim<sup>21</sup> found in twenty-five cases of primary syphilis that the Kahn reaction was slightly more sensitive than either a highly sensitive or a conservative Wassermann. Houghton, Hunter, and Cajigas<sup>22</sup> in thirty-eight cases of primary syphilis found complete accord between the Kahn and Wassermann in thirty, and in the remaining cases the Kahn was positive, while the Wassermann was negative.

Willett and Nagel<sup>23</sup> in 187 cases of primary syphilis of less than twenty-eight days duration found the Kahn reaction positive in 80 per cent., while the "dark field" was positive in 61 per cent.; 105 of these cases were clinically luetic by the "dark field" and Kahn combined. They concluded that the Kahn is very sensitive in chancres of even less than one week's duration.

McIntyre and Gilman<sup>24</sup> in twenty-one cases of early untreated syphilis found the Kahn reaction strongly positive in fourteen, weakly positive in six, and negative in one.

In "secondary lues" the Wassermann reaction is notably more nearly uniformly positive than at any other stage of the disease. So is also the Kahn test. Kahn and Keim<sup>21</sup> in sixty-four cases of secondary syphilis found complete accord between the Kahn test, a highly sensitive Wassermann, and a conservative Wassermann test; sixty-two cases were definitely positive by all three tests, one weakly positive, and one negative.

Houghton, Hunter, and Cajigas<sup>22</sup> in 273 cases of secondary lues found positive Kahn and Wassermann tests in 268, and positive Kahn reactions in the five remaining.

Hazen<sup>7</sup> in twenty-five cases finds complete agreement between the two methods.

McIntyre and Gilman<sup>24</sup> in 208 cases found the Kahn reaction positive in 59 per cent., and the Wassermann-Kolmer modification in 61.5 per cent. However, treated cases were included, and weakly positive reactions were counted as negative. Allowing for this, their results show the Kahn test more sensitive and reliable.

It is accordingly very generally agreed that the Kahn reaction is nearly uniformly positive in untreated secondary lues.

With regard to "tertiary lues," Hazen<sup>25</sup> in his book on Syphilis, refers to the work of Kahn and Keim saying that the Kahn test was found in a series of eighty-seven cases of tertiary syphilis to be more sensitive than a sensitive or a conservative Wassermann, except that in visceral syphilis it merely compared favorably with the more sensitive Wassermann; seventy-six of these cases were positive by the Kahn test. In cerebrospinal syphilis (192 cases) the reactions with the Kahn fell about midway between the highly sensitive and conservative Wassermans. In 218 cases of latent syphilis he found the Kahn agreed with the more sensitive Wassermann; 169 specimens of cerebrospinal fluid taken from cases of cerebrospinal syphilis were positive by the Kahn method, and 184 specimens of cerebrospinal fluid from the cases of latent syphilis proved positive. This work was early (1924), but the specificity of the Kahn reaction is noteworthy.

Houghton, Hunter and Cajigas<sup>22</sup> in 474 cases of tertiary syphilis found positive Kahn reactions in 463, and in 424 cases of latent lues found positive Kahn reactions in 397. A parallel Wassermann reaction in both groups of cases was not so sensitive; 458 positive results were found in the "tertiary" group and 350 in the "latent" group.

Kelly<sup>26</sup> in sixty-seven cases of latent syphilis found the Kahn reaction positive in sixty-six, and the (Kolmer) Wassermann positive in sixty-four. He found both reactions positive in thirty-four cases of tertiary syphilis, and in six cases of neuro-



syphilis the Kahn reaction was positive in six, whereas the Wassermann was positive in five.

Dudgeon,<sup>27</sup> examining the sera of ninety-three cases of general paresis, found the Kahn and Wassermann reactions both positive in eighty-three.

Apparently the Kahn reaction is positive in about 80 per cent. of all cases of tertiary lues, and if only untreated cases were to be considered, the percentage would undoubtedly be higher still.

With respect to congenital lues, Kelly<sup>28</sup> in five cases of congenital syphilis found both the Kahn and Wassermann reactions positive in all.

In congenital lues, Houghton, Hunter and Cajigas<sup>29</sup> in eight cases found uniformly positive Kahn and Wassermann reactions. Hazen<sup>30</sup> in thirty-nine cases found the Kahn reaction positive in thirty-four. He says that the Kahn test is more specific in such cases than a highly sensitive Wassermann reaction.

Fox and Sanderson<sup>31</sup> found the Kahn reaction positive in four of five untreated cases, and in seven of ten treated cases of congenital syphilis; their work, however, was performed in the early period of the development of the technic.

Important from the practical point of view is also the circumstance that the Kahn test gives no *anti-complementary* reactions. The substance which fixes complement in the absence of antigen does not produce a positive precipitation reaction.

We believe that the results reported in this communication—as they concern the serodiagnosis of syphilis—are of particular significance; (1) because of the method used (the Kahn test), and (2) because the test was performed solely for purposes of this investigation and every step in the laboratory part of the investigation was carefully supervised by one of us (R. A. C.) from the time blood was taken from the patient in the clinic, until the final readings of the reactions were made and recorded in the laboratory. The reliability and sensitivity of the Kahn reaction has just previously been discussed, and in the use of this test, we feel that we have undoubtedly a serodiagnostic reaction which is the equal of any and the superior of many of the tests used by previous investigators in connection with statistics covering the incidence of syphilis. At all events, the Kahn reaction has not been frequently used for the purpose under discussion. In the collection of blood from patients in the clinic, every precaution was taken to insure freedom from contamination either by particles of foreign material in suspension, or by chemical substances. Blood was received, for the most part, into vacuum tubes of the Keidel variety, and was transported from the clinic directly to the laboratory in the original containers. Samples of blood were invariably subjected to the Kahn test on the afternoon of the day in which they were received, and usually within a period of two or three hours. No pains were spared in the preparation of a thoroughly reliable and sensitive antigen, and during the course of the preparation of this antigen several preparations, which were found to be not particularly sensitive, were rejected. The glassware used in the performance of the test was prepared strictly in accordance with the principles enunciated by Kahn in his text book on the precipitation reaction. Inactivation of the samples of serum was performed at 56° centigrade for thirty minutes. All the manipulations incident to the per-

formance of the reaction were performed either by the senior author personally or by a thoroughly reliable and well-trained laboratory technician\* under his direct guidance and personal supervision. In cases in which doubtful reactions were obtained, or in which there was any suspicion that inaccuracy might have crept into the technic of the procedure, final results were disregarded, and the entire test was repeated from start to finish. The results were read personally by the senior author. The technician was also required to make independent readings. These almost invariably corresponded with the senior author's readings, but in those cases in which there was a slight discrepancy the test was repeated.

The reactions in each of the three test-tubes used in the test were recorded in the form of "1," "2," "3," and "4+"; "4+" representing a strongly positive precipitation reaction, and "1+" representing a precipitation which, though distinct, was relatively slight. The reactions for all three tubes were added and divided by three to give the final reading. In cases in which any slight doubt existed, as to whether the serum was positive or negative, the reaction was recorded as "negative." Positive and negative controls were included in each series of test tubes, and especial pains were taken to insure the absolute clarity of all sera prior to dilution. The final readings of all sera were recorded by the senior author and the laboratory technician before the clinical records of any of the cases were consulted for verification.

*Results: Incidence of Syphilis as Shown by the Kahn Test.*—As previously stated, the results obtained in this study are based upon a consideration of 509 clinical cases. In recording the results upon which the figures about to be given are based, "3+" and "4+" Kahn reactions are considered as *prima facie* evidence of syphilitic infection. Of the cases giving such reaction there were 142, or 28.1 per cent.

Kahn reactions not sufficiently positive to be read as "2+" were recorded not as "1+" but as "negative," and therefore only the cases showing "2+" reactions remain to be discussed. Of these there were 110 in all, and, if these be added directly to the "3+" and "4+" reactions just previously mentioned the total is 252 cases, and the total percentage of cases in the entire series thus shown to be syphilitic is 49.5. Kahn reactions of "2+" and less alone are not, however, customarily regarded as indisputable evidence of active luetic infection, and therefore an attempt is made still further to analyze the cases showing "2+" reactions.

As previously mentioned, 304 cases were examined completely, both clinically and serologically. These cases will subsequently be classed as belonging to "Group I." In "Group I" cases giving "2+" reactions were separated for purposes of further consideration into two sub-classes: (1) those cases with a "2+" Kahn reaction which were reinforced by a history of definite syphilitic infection as shown by previous positive serology or a history of unmistakably specific treatment, and (2) those cases with a

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\* Rubye A. J. Wilson.

"2+" reaction unsubstantiated by such a history; the latter were regarded as "negative."

Unmistakably specific previous treatment, as thus considered, consisted of the intravenous injection of the arsenicals, salvarsan or neosalvarsan. Presumably antisyphilitic treatment per orem or by intramuscular injection was not considered as adequate evidence of previous antisyphilitic treatment. In only one instance was an exception made to this rule, and this in the case of two brothers, aged eight and thirteen years respectively, in whom there were definite clinical manifestations of congenital lues, and both of whom gave a "2+" reaction.

Twenty cases fell within such a classification, and adding these to the eighty-eight cases in "Group I" which showed a "3+" or "4+" reaction, the total is 108 cases or 35.5 per cent. This is, of course, considered to be a too conservative estimate of the actual incidence of luetic infection, since not only does it eliminate, regardless of physical findings, twenty-two cases in which a "2+" Kahn reaction was obtained, but also any cases not showing positive serology as a result of previous treatment, as well as cases clinically luetic, but serologically doubtful or negative.

In the series of cases investigated solely from the point of view of serology—subsequently called "Group II"—there were 205 cases. Of these cases fifty-four presented "3" or "4+" Kahn reactions, a percentage of 26.3 per cent. as compared with 21.1 per cent. in the series of cases previously mentioned. There were forty-eight cases presenting "2+" Kahn reactions, and these obviously could not be subdivided on a basis of the clinical history. These cases represent a percentage of 23.4. Adding together the series of "3+" and "4+" and the series of "2+" Kahn reactions, there is a total of 102 cases, or 45.7 per cent., which corresponds very closely, as will be seen, with the 49.3 per cent. of the previous group. It can therefore be safely assumed that had these cases been investigated clinically, as well as serologically, the distribution of "2+" cases would undoubtedly have been essentially as in the previous group.

Re-stating the results in tabular form they appear as below :

TABLE I

	No. of Cases	3+ and 4+ Kahns		2+ Kahns with Clinical Evidence of Lues		Doubtful 2+ Reactions		Negative	
		No.	%	No.	%	No.	%	No.	%
Group I.....	304	88	28.9	20	6.6	42	13.8	154	50.7
Group II.....	205	54	26.3	.....	.....	48	23.4	103	50.3
Total.....	509	142	27.9	(20)	(3.9)	90	17.8	257	50.4

Group I shows cases studied both clinically and serologically.

Group II shows cases studied serologically only.

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Since the incidence of syphilitic infection must almost inevitably vary with the age period of the patients considered, syphilis being fundamentally a disease contracted venereally, we have analyzed our results according to age periods as follows: six to ten years, eleven to twenty years, twenty-one to thirty years, thirty-one to forty years, forty-one to fifty years, fifty-one to sixty years, and sixty-one to seventy years.

As a result of this analysis it appears that a positive serology is encountered somewhat more than twice as frequently in the second decade than in the first, more than twice as frequently in the third decade as in the second, and in a generally somewhat decreasing frequency in subsequent decades.

Children below the age of ten years can with reasonable surety be presumed to be suffering from congenital rather than acquired syphilis in cases in which infection can be demonstrated, and it is interesting to note that in the present series of cases there is some reason for believing that congenital syphilis is more likely to yield a "broken" reaction than is the acquired variety, "2+" reactions being the rule in this class of cases.

That a considerable number of negro boys contract syphilis by the venereal route before the age of twenty years is apparently demonstrated, since the incidence of infection as shown by the Kahn test increases markedly in this age period. The period of greatest sexual activity, however, represented by the age period twenty-one to thirty, does not yield the highest percentage of infection, but, rather, the succeeding decade thirty-one to forty.

The percentage of negro men in the succeeding decades of life who show positive serology is somewhat surprising. Apparently, judging from these figures, either syphilis in the negro is not associated with a very high mortality rate, or else many negroes contract the disease comparatively late in life, thus maintaining a high incidence even into late life.

A tabular review of the results follows:

TABLE II  
*Serological Reactions According to Age in Group I*

Age in Years	Negatives	3 and 4+ Kahns 2+ Kahns Clinically Confirmed	2+ Kahns Negative History	Total Cases	Percent- age of Negatives	Percent- age of the 3 and 4+ Kahns 2+ Confirmed	Percent- age of 2+ Kahns Negative History
6-10.....	24	3	6	33	72.7	9.1	18.2
11-20.....	44	14	10	68	64.7	20.6	14.7
21-30.....	37	43	12	92	40.2	46.7	13.1
31-40.....	25	30	6	61	40.9	49.1	10.0
41-50.....	16	12	6	34	47.0	35.3	17.7
51-60.....	3	4	2	9	33.3	44.4	22.3
61-70.....	4	3	0	7	57.1	42.9	0.0

*Comment.*—One question legitimately raised by any study purporting to estimate the incidence of syphilitic infection primarily on the basis of a sero-diagnostic test must be briefly considered—in any general series of patients

TABLE III  
*Serological Reactions According to Age in Group II*

Age in Years	Negatives	3 and 4+ Kahns	2+ Kahns	Total Number	Percent- age of Negatives	Percent- age of 3 and 4+ Kahns	Percent- age of 2+ Kahns
6-10.....	10	3	8	21	47.6	14.3	38.1
11-20.....	30	8	8	46	65.2	17.4	17.4
21-30.....	35	20	21	76	46.0	26.3	27.7
31-40.....	11	13	6	30	36.6	43.4	20.0
41-50.....	10	6	3	19	52.6	31.6	15.8
51-60.....	7	3	1	11	63.6	27.3	9.1
61-70.....	1	0	1	2	50.0	0.0	50.0

including patients of different ages and both treated and untreated cases what proportion of infections will remain undetected? Unfortunately the present study sheds very little light on the question. Ultimately the solution of the problem resolves itself into (1) finding some additional method for the absolute detection of syphilitic infection, and (2) the discovery of some method of serodiagnosis which yields no "false positive" reactions. For the present, more or less circumstantial evidence alone is available in attempting to settle such a question.

McIntyre and Gilman<sup>24</sup> in 1394 cases of "proven" syphilis found the Kahn test positive in 70.5 per cent., whereas the Kolmer test was positive in 68.3 per cent., but this group included treated cases in large numbers.

Johnson<sup>25</sup> in 1613 "cases of syphilis" found the Kahn failed to yield positive results in only 11.1 per cent. of cases whereas the Wassermann failed in 13.8 per cent.

Walker<sup>26</sup> in 181 cases "clinically luetic" found the Kahn reaction positive in all, whereas the Wassermann was positive in only 107.

Thompson and Ebel<sup>21</sup> in 10,000 cases found the Kahn test failed to detect syphilis in only 6.9 per cent., whereas the Wassermann failed in 9.1 per cent.

In the League of Nations Competition the Kahn test detected only 303 out of 499 cases, but in this series probably too many sera from treated and tertiary cases were included, though its specificity exceeded that of the Wassermann reaction.

Possibly it may be taken as a representative opinion that the Kahn reaction may be expected to fail in the detection of syphilis in not more than 10 per cent. of cases unless special factors complicate the situation, such as the inclusion of a large number of well-treated cases in the series. In untreated cases there should be not more than 1 to 3 per cent of discrepancies. Since there is no reason for supposing that the present series of cases includes any considerable number of unusually well-treated cases the margin of error is undoubtedly somewhat less than 10 per cent in the report. The effect of this error is, of course, to increase, and not to decrease, the figures presented.

The error introduced by possible false positive reactions is probably negligible.

Kahn and Keim<sup>21</sup> in 1924 reported two "1+" reactions and two

"2+" reactions in 1,975 cases, victims of dermatological conditions apparently non-syphilitic. The next year Keim<sup>32</sup> reported in 2,500 cases clinically free from syphilis, four "1+" reactions, two "2+" reactions, and one "3+" reaction. Later, Thompson and Ebel<sup>31</sup> in 10,000 cases found that the Kahn test never gave false positives.

Still later Kahn<sup>33</sup> in reporting on 150,000 Kahn tests says that fewer than six questions of specificity were raised in all the tests. Finally, in the League of Nations Competition on 429 non-syphilitic cases the Kahn test was noteworthy as giving no false positives.

Apparently the Kahn test is as specific for syphilis as any that has ever been devised.

In leprosy Yagle and Kolmer<sup>34</sup> found in twenty-eight samples of serum from lepers, positive Kahn reactions in three cases which were definitely syphilitic, and one "doubtful" reaction in another case suspiciously syphilitic. The remaining twenty-four specimens were negative. Maxwell<sup>35</sup> found the Kahn reaction positive in all cases of secondary yaws, but negative otherwise. This is not surprising since yaws and syphilis are probably identical etiologically. Mu and Keim<sup>36</sup> in 106 patients with acute febrile disease found positive Kahn reactions in eighteen, but twelve of these were clinically luetic. Four of the remaining six reactions were doubtfully positive and became negative during convalescence. Two, however, remained positive. It may be concluded that a positive Kahn reaction is peculiar to the disease syphilis.

*The Incidence of Concurrence between Clinical Diagnosis and Serological Findings in the Present Report.*—The authors make no pretense to any especial knowledge of syphilology and the percentage of cases clinically diagnosed by them in this series with accuracy is undoubtedly considerably smaller than would be attained by one especially trained in the clinical recognition of the disease. Nevertheless, it is of some significance that there was a 74.1 per cent. accord in this series between the clinical diagnosis as recorded in the clinic and the strictest interpretation of the serological reactions. By this is meant that only those cases showing "3+" or "4+" serological reactions or "2+" reactions confirmed by a definite history of previous treatment were considered as positive, and a mistake in diagnosis was considered to have been made not only in those cases in which a negative diagnosis was made in the case of a "2+" unconfirmed Kahn test, but also in those cases in which a positive diagnosis was made in the case of a "2+" unconfirmed Kahn reaction. The correlation between clinical diagnosis and serological findings is really, therefore, probably somewhat more complete than the actual figures indicate. Of the "errors" in diagnosis, 53.6 per cent resulted from failure to recognize the disease when present according to the Kahn test—"errors of conservatism"—46.4 per cent. represented the reverse. The authors, therefore, apparently showed no especial tendency to exaggerate the probable prevalence of the disease in their clinical deliberations.

## CONCLUSIONS

I. The statistical study herein reported is believed to be of especial significance since:

- (a) Both the serological reactions and physical examinations upon which the report is based were undertaken for the sole purpose of this study and were performed personally by the authors.
- (b) The number of cases (509), though not particularly large, is probably of sufficient proportions to yield an accurate estimate of the incidence of syphilis in the particular group of persons considered.
- (c) The Kahn test, which was used for purposes of serodiagnosis, is probably more sensitive than most complement-fixation reactions (Wassermann tests) and therefore yields unusually reliable information with respect to the presence of syphilitic infection.
- (d) The cases examined were consecutive cases, a consideration which definitely tends to eliminate the factor of "selection".

II. The most conservative percentage incidence of syphilis which can possibly be derived from this series of cases is 35.5 per cent., which represents only those cases showing either a "3+" or "4+" Kahn reaction or a "2+" Kahn reaction confirmed by a definite history of previous anti-syphilitic treatment. If uncorroborated "2+" reactions be included the percentage incidence becomes much higher, viz. 49.5. Even the latter figure, however, does not include cases clinically syphilitic but serologically negative or cases rendered serologically negative by previous treatment.

III. Considering only the adults in the series, even the most conservative percentage incidence of syphilis is 49.1 per cent. in the age period thirty-one to forty, 46.7 per cent. in the age period twenty-one to thirty, and 44.4 per cent. in the age period fifty-one to sixty.

IV. Of much interest is the finding that the incidence of syphilis in the age period eleven to twenty is more than double that in the age period six to ten, while the incidence more than doubles again during the age period twenty-one to thirty, and does not reach a peak until the following decade, thirty-one to forty.

V. According to the most conservative estimation that can be computed the clinical diagnosis of syphilitic infection in the patients considered can be made by the surgeon in at least 74.1 per cent. of cases without recourse to serology.

VI. Considering the ultra-conservative nature of the methods used in arriving at the figures presented in this communication together with the fact that most of the patients examined found their way into the clinic not because of any symptoms referable to their systemic diseases, but rather as the result of more or less adventitious injuries, there seems to be reason for believing that the incidence of syphilis amongst negro males in New Orleans is greater than has been reported for any group of persons, white or colored, within the knowledge of the authors.

# SYPHILIS AMONG SOUTHERN NEGRO MALES

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# TRANSACTIONS

OF THE

## NEW YORK SURGICAL SOCIETY

STATED MEETING HELD NOVEMBER 27, 1929

The President, DR. EDWIN BEER, in the Chair

### HÆMOLYTIC STREPTOCOCCUS GANGRENE FOLLOWING THE ADMINISTRATION OF SCARLET FEVER ANTITOXIN

DR. FRANK L. MELENEY presented an eight-year-old girl who was admitted to the Presbyterian Hospital June 25, 1929, complaining of a spreading ulcer of the buttock, thigh and abdomen, of six weeks' duration. Seven weeks before admission she had received a small prophylactic dose of scarlet fever serum into the right buttock when an older sister came down with the disease. Four days later she herself developed typical scarlet, with fever, sore throat, vomiting and rash. She was then given a large dose of scarlet fever antitoxin in the left buttock. The swelling caused by this injection, instead of subsiding promptly, on the second day began to increase. On the fourth day the skin became dusky and bullæ and blisters formed. This went on to frank gangrene of the skin over a large area of the left buttock. She was seen by a surgeon who advised conservative treatment. Each day the temperature mounted to 103 or 104, and the process spread down the thigh and across the abdomen. Finally the surgeon cut away the dead skin, but the process continued to spread. Still later other small incisions were made, but did not halt the steady progress of the infection nor lower the temperature. When seen by the reporter, she was in an exhausted nervous state from painful daily dressings and a daily rise of temperature from 103 to 105 with frequent chills. There was a large ragged granulating surface on the left buttock extending over to the outer and anterior surface of the abdomen and down the lateral surface of the thigh. There were heavy swollen indurated margins on all sides with undermined skin revealing extensive necrosis of the subcutaneous tissues. Small incisions were present in the right inguinal region, left femoral region and left loin. She was brought to the hospital from her home and extensive incisions were made in all directions, opening widely the tissues. For four days she was treated with wet dressings and hourly poultices, and the whole process promptly subsided. The indurated margins became soft and then Dakin's solution was instilled by means of Carrel tubes. The slough promptly separated and on the eighth day it was possible to skin graft a portion of the ulcerated area on the lower thigh. Later, as the skin margins became adherent and new epithelium began to grow in, the whole area was covered with pinch grafts in two sessions, first anteriorly and then posteriorly. There was some delay in final healing due to rolled-in skin margins in several places, but when these were trimmed away they promptly healed.

The case is presented (1) because it illustrates the disastrous results which occur if the hæmolytic streptococcus gangrene is not recognized early, and adequate surgical interference is not instituted at once; (2) because it brings up the question of the pathogenesis of this extraordinary disease.

The exceedingly rapid development of necrosis in this type of streptococcus infection resembles strikingly the necrosis which takes place in experimental animals which have been made hypersensitive or allergic. Hypersensitivity to bacterial products resulting in necrosis of tissue has at least two different manifestations. First that which Zinsser and Grinnell,<sup>1</sup> MacKenzie and Woo,<sup>2</sup> Julianelle and Avery,<sup>3</sup> and others have described which consists of a phase of hypersensitivity in the course of repeated weekly intradermal inoculations of bacterial extracts or autolysates coming on about three to four weeks after the first injection, lasting a week or ten days and then passing off. In this phase the injections produce extensive œdema of the tissues with central necrosis of the skin. Zinsser and Grinnell found that certain old guinea-pigs were hypersensitive to the primary inoculation and concluded that they must have been made so by previous contact with the organisms. Bull and McKee<sup>4</sup> have shown that following intranasal inoculation of pneumococcus culture the experimental animal passes through a phase of hypersensitivity which can be demonstrated in the same way by intradermal inoculation. The second hypersensitive manifestation is that which has recently been observed and studied by Schwartzman.<sup>5</sup> He has found that when filtrates of certain organisms are injected into the skin of animals, there is little or no primary reaction, but twenty-four hours later, if the same filtrate be injected into the vein of the animal, the areas of previous intradermal injection within a few hours become swollen and red and then certain portions turn blue, blisters form and frank gangrene of the tissues develops. This phase of hypersensitivity only lasts for about twenty-four to forty-eight hours after the primary inoculation, but the reaction is more severe than in the other type.

Which of these types of reaction is represented in these cases of hæmolytic streptococcus gangrene it is hard to say. This particular case which has been presented may very well have been in a hypersensitive state because of previous contact with the organism from her sister and the fact that she received a preliminary prophylactic antitoxin injection. Her secondary insult may have come via the blood stream from her throat, thus simulating the Schwartzman reaction. Several of the cases seen by the reporter in China<sup>6</sup> had had previous lesions in the neighborhood. Several had received repeated hypodermic injections. Several others had had blisters for some days or weeks previously. One with scabies had been scratching himself for some time. These might be explained by the other type of reaction. One more fact which would tend to substantiate the hypersensitivity theory is that when cultures are taken from the lesions, it is found that there is a wide zone of sterile œdema, organisms are only found in the tissue which is actually necrotic and then usually in relatively small numbers. This theory of pathogenesis does not in any way modify the proper method of treatment in these cases which require early extensive incisions, and until we come to have a better understanding of the condition and methods of prevention, the cases will come to us full blown and in need of prompt surgical intervention.<sup>7</sup>

## PIGMENTATION ASSOCIATED WITH OBSTRUCTION OF BILE DUCT

DR. ALLEN O. WHIPPLE said that he would like to emphasize the point that Doctor Meleney brought out in regard to the importance of the early recognition of these lesions. This will not only save the patient from subsequent distressing scars, but very often from death resulting from the severity of the unrecognized infection. These cases occur quite frequently in New York, but are often overlooked, although it is well known that they are quite common in China. Many cases of so-called erysipelas should be watched, with the possibility of gangrene in mind, until they developed certain earmarks that made them fairly distinct from other streptococcus infections. Certainly the results are astonishing when the disease is recognized early.

DOCTOR MELENEY rejoined that he had seen about fourteen of these cases in the last five years, half at the Presbyterian Hospital; the other half at other hospitals. In conversation with several surgeons he has learned that many of them have seen one or two cases. In this particular instance the family physician did not recognize the disease. One of the consulting surgeons, in looking up the literature, had found Doctor Meleney's report of cases seen in China and in this country and then asked him to see the patient. Naturally, those who have not seen these cases have overlooked the reports in the literature.

## UNUSUAL PIGMENTATION ASSOCIATED WITH OBSTRUCTION OF THE COMMON BILE DUCT

DR. FRANK L. MELENEY presented a woman, sixty-three years of age, who was admitted to the Presbyterian Hospital July 22, 1929, complaining of intermittent attacks of epigastric pain and jaundice of four months' duration. For four years she had occasional disturbance of digestion usually consisting of a feeling of distention, but at times severe attacks of epigastric pain coming usually after eating; sharp stabbing in character, and radiating to the back. She was troubled with belching, particularly after eating fatty foods. Four months before admission she had an unusually severe and prolonged attack of pain of the same character, with repeated vomiting. Jaundice developed with dark urine and pale stools. Itching of the skin was distressing and anorexia profound. Constipation was only relieved by enemas. She had fever and several shaking chills. After two weeks, the pain subsided somewhat and the jaundice of her conjunctivæ cleared, but her skin remained dark yellow. Following the first attack she had a series of milder attacks and her skin became darker with each attack. Although she was urged to go to a hospital, she persistently refused until finally at the end of a prolonged attack lasting for three weeks, with pain, anorexia, fever and deepening jaundice, she consented. During this period of four months her doctors gave her pepsenzyme tablets, compound sodium glycolate, caroid and bile salts, bismuth salol, codeine, Carlsbad salts, and cholegestive on various occasions. In her past history the only things worthy of note were two pregnancies, irregular habits of eating, no typhoid fever, but malaria and rheumatism in childhood, and a severe attack of pneumonia twelve years ago. Has not taken patent medicines or drugs. Family history negative.

On admission she was described as an elderly, colored woman with deep jaundice of skin and of conjunctivæ. The skin was dark brown all over, uniform in color, with generally distributed scratch marks. She was well developed and fairly well nourished, but with evident loss of weight. There

were several bad teeth with many missing and pyorrhea around those which remained. Neck and chest were normal. Abdomen was moderately distended. There was no spasm, but marked local tenderness in the R. U. Q. The liver edge could be felt just below the costal margin. Pelvis was negative. Extremities negative. Temperature 99.2°. Blood pressure 120/68. Her blood count showed 80 per cent hæmoglobin, with 3,430,000 red cells, 12,600 white cells, of which 66 per cent were polymorphonuclears, and 30 per cent lymphocytes. Blood Wassermann was negative. Blood urea normal. Serum bilirubin 15 milligrams per 100 cubic centimetres. Urine was strongly positive for bile. The stool was pale brown with considerable amount of undigested food. It was positive for bile and negative for blood. Bleeding and clotting times were normal, but she was given infusion of calcium lactate daily preliminary to operation. At operation, the liver was found to be enlarged, smooth, jaundiced, but not sclerotic. The gall-bladder was hard and shrunken. It contained a stone and there was another in the cystic duct. The common duct was enormously dilated, at least 3 centimetres in diameter, and contained white bile. A stone was impacted in the ampulla of Vater. This was removed. The gall-bladder was excised, a rubber tube drain was placed in the common duct, another into Morrison's pouch, and a cigarette drain along the gall-bladder bed of the liver. She drained 60 cubic centimetres of white bile for a day and then it became normal in color. During the first three days there was a mild but prolonged condition of shock, but thereafter the convalescence was very satisfactory, the jaundice of the scleræ rapidly cleared and the serum bilirubin fell to normal, but the skin remained as before. She was discharged on the twenty-second day after operation. She went home pending arrangements to be made by the social service department for convalescent care, but this was difficult to arrange because patient was considered to be a negress. It was not until a month later that it was discovered to everyone's surprise, except herself, that she was not a negress. She was astounded that she had ever been considered such. Patient returned to the Follow-up clinic two months after operation. She said that she was beginning to get lighter. A photograph was taken. She was referred to the skin clinic for opinion, but failed to keep the appointment. Finally, Doctor Hopkins saw her three months after operation, about three weeks ago. At that time her color had perceptibly cleared. He said that he had never seen a case like it, but said it might be due to prolonged jaundice or might be due to arsenic or hemochromatosis. Doctor Hopkins thought hemochromatosis could be ruled out by the absence of liver cirrhosis and absence of glycosuria, and general symptoms. Ochronosis was ruled out by the urine test for alcaptonuria. Arsenic pigmentation was studied by examination of the blood and urine. The blood showed 0.11 milligram per 100 grams of dried blood. Normal upper limit is 0.05 milligram. Addison's disease is ruled out by a high normal blood pressure and absence of general symptoms. Because of its coincidence with the jaundice and its even distribution, the absence of a history of arsenic medication, and its general clearing the most likely cause of the pigmentation would seem to be the jaundice, in spite of the high blood arsenic.

#### LOCAL PERITONITIS OF THE PROXIMAL END OF THE JEJUNUM

DR. FRANK L. MELENEY presented an unmarried woman of twenty-two years, who was admitted to the Presbyterian Hospital September 22, 1927, complaining of severe pain in the right upper quadrant of the abdomen of two days' duration. The attack had come suddenly with severe cramp-like pain radiating to the back and right shoulder. Anorexia was present without nausea or vomiting, but with some fever and a chill on the second day. No

## CIRCULAR ULCER OF JEJUNUM CAUSING OBSTRUCTION

jaundice was noted, but stools were pale. Bowels had moved each day and there were no urinary symptoms. She had had no previous attacks and had always been well. There was no history of digestive disturbances and no history of typhoid fever. Examination was negative except for the abdomen. There was slight rigidity in the R. U. Q., and marked tenderness there as well as over the costal margin, with less in the epigastrium and paraumbilical region. Temperature, was 100.4 and pulse 88. Urine examination was negative. White blood corpuscles were 17,200 with 84 per cent. polymorphonuclears. X-ray film was negative for stones in gall-bladder, kidneys and ureters, and no calcified glands were seen. The diagnosis of acute cholecystitis seemed to be fairly certain. At that time following a series of cases of gall-bladder disease, both questionable and straightforward, all of which had been cholecystographed, they had stopped making cholecystograms on straightforward gall-bladder cases, and it was not done in this case. With rest in bed and local applications of cold, the pain and tenderness subsided. Temperature and blood count fell and she felt better. Pain, however, recurred intermittently and on the fourth day her temperature began to rise again and it was thought best to proceed with the operation. The gall-bladder was found to be perfectly normal. The stomach and duodenum were likewise normal. On lifting up the omentum, the upper jejunum, for a distance of about two feet from the duodenal jejunal junction downward, was found to be dilated, reddened and shaggy with fibrin. At the angle of Treitz there was a plaque of fibrin on the jejunum. Palpation failed to reveal any induration as from an ulcer or any actual perforation. Likewise, pressure on the gut failed to produce leakage. This was almost certainly the site of origin of the inflammatory process, but it had become effectively sealed and the abdominal wound was therefore closed without further interference. She made an uneventful recovery, and has had no symptoms now for two years. In the absence of local induration and a history of digestive symptoms and the subsequent course of the case, an ulcer seemed unlikely. The most probable cause seemed to be a perforation by a foreign body, subsequently passed on. On inquiry, it was found that she had eaten fish four days previously, and admitted that she might have swallowed a bone.

He presented the case, (1) because of its unusual pathology; (2) because of its unknown pathogenesis; (3) because it simulated symptomatically a common disease; (4) because it illustrates the fact that a diagnosis of gall-bladder disease in a woman who has never been pregnant and never had typhoid fever should be made with hesitation and reservations; (5) because it brings up the question of whether or not a cholecystogram should be done in all cases of possible gall-gladder disease.

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## CIRCULAR ULCER OF JEJUNUM CAUSING OBSTRUCTION

DR. OTTO C. PICKHARDT presented a woman, aged sixty, who was admitted to the Lenox Hill Hospital December 24, 1927. Her present history

dated back three weeks, at which time she had her first attack of generalized abdominal cramps associated with vomiting. These cramps were intermittent in character and quite severe. On the day previous to admission she had had her severest attack and the vomiting had lasted throughout the entire night. During this time she had had several bowel movements, although as a general rule she was markedly constipated. There had been no fever, no pulse, no jaundice, no coughing. Her past history was negative for the present condition, having had asthma ten years ago, rheumatic fever twenty-five years ago, and the menopause ten years ago. She was fairly well nourished, and did not appear acutely ill. The heart showed evidence of chronic cardiac valvular disease, but the rate was regular—80—and there was no pulse deficit. The abdomen was moderately distended, but there was no rigidity and no definite points of tenderness. There was more tympany over the upper portion than over the lower. No masses were palpable, and there were no operative scars. No visible peristalsis could be seen. In the right groin, more in the area of the femoral region than in the inguinal, there was a walnut-sized, soft, freely movable, rather tender mass, which gave a slight impulse on coughing, but did not change in size when the patient coughed or stood (patient states that she had had this for years). This mass gave the impression of being an irreducible, but not strangulated, hernial protrusion of long standing. The remainder of the physical examination was irrelevant.

A barium clysma röntgenogram, which had already been taken, suggested a twist at about the junction of the descending colon and the sigmoid, possibly due to a band of adhesions. Besides this there is a shadow in the region of the right ureter.

The blood count showed W.B.C. 9,900; polys 80 per cent.; urine showed some albumen and scattered pus cells. The Wassermann was negative. The temperature, pulse, and respiration were normal. Blood pressure 170/90.

The patient was evidently suffering from some type of partial, intestinal obstruction, which at present had relieved itself. The condition may be due to (1) an obstruction by a band in the lower large bowel, or (2) to a reducible hernia, or (3) reflexly to a stone in the ureter. She was observed for a period of two weeks, during which time she had several attacks, similar to those described above, and it was noted that they almost invariably followed the giving of a cathartic to relieve her constipation. A cystoscopy with catheterization of the ureter was negative. Numerous further X-rays, both barium meals and barium clysmas followed, but showed no evidence of an existing intestinal obstruction. Finally, after a particularly severe attack, she was operated upon January 9, 1928. In the large intestine nothing abnormal was found except that the sigmoid was rather redundant. Several unexplained bands of adhesions and bands of omentum were found and loosened. The small intestine was found partially distended. The distended gut was then followed and within about five feet it ended at the duodeno-jejunal flexure. The distal end was then examined and within about a foot there was found a firm, thumb-sized circular stricture about one and one-half inches long. This felt quite firm and was slightly reddened and injected, but showed no evidence of ulceration on the serosal surface. It did not give the impression of an acute kink or intussusception, but more of a chronic inflammatory process within the lumen of the gut, possibly carcinomatous in nature. After observing it for a time and seeing that no change occurred, it was decided to resect about six inches of the jejunum. This was done by means of clamps and the excision with the actual cautery. The open ends of the gut were then inverted with double pursestring suture

## CONGENITAL RECTO-VAGINAL FISTULA WITH IMPERFORATE ANUS

and a side-to-side anastomosis by suture, using silk for the serosa and chromic for the deep tissues, was then done. The cut ends of the mesentery were then sutured to the mesentery itself by a few plain gut sutures. Omentum pulled down over the anastomosed area and the gut returned to the peritoneal cavity directly beneath the abdominal wound. Wound closed in layers, using plain gut for peritoneum, interrupted chromic for muscle, silk-worm and silk for skin, and subcutaneous split rubber tube drain introduced.

The specimen, received in the fresh state, consisted of an 11 centimetre long piece of intestine. A 2 centimetre wide band of tissue divides the specimen into a dilated proximal part (6 centimetres long and 6 centimetres in circumference) and a narrow distal part (3 centimetres long and 4 centimetres in circumference). The obstructing band of tissue feels distinctly harder than the rest of the intestine. The mucosa over this area has been ulcerated away, and the floor of the ulcer presents a granular appearance.

Microscopically sections of the gut showed a superficial ulceration, which was confined to the mucous membrane. The floor of the ulcer was composed of granulated tissue crowded with lymphoid cells, plasma cells, and polymorphonuclear leucocytes. The submucosa was greatly thickened by fibrosis and oedema, and irregularly infiltrated with many small round cells and plasma cells. The muscular and serous coats show fibrosis and an inflammatory cell infiltration of a lesser grade. There was no suggestive vascular lesion.

Her recovery was uneventful and several complete X-ray examinations taken at yearly intervals showed no further evidence of obstruction. Her symptoms have disappeared, she has gained weight and feels well.

## CONGENITAL RECTO-VAGINAL FISTULA WITH IMPERFORATE ANUS

DR. O. C. PICKHARDT presented a girl, aged seven years, who was admitted to the Lenox Hill Hospital, October 25, 1928. She was born in Roumania, the first child, normal delivery, the mother being attended by a midwife. The child had its first movement three days after birth and nothing amiss was noted until at the end of six weeks the mother noticed that the bowel movements were coming through the vagina and that there was no rectal opening. At twenty-one months some type of operation was done in Roumania, after which time fecal material came out both through the vagina and either through an opening made through the imperforate anus or through an opening in the left buttock. This latter opening remained patent for only two weeks and then closed spontaneously, and had been closed ever since. The parents were advised that nothing should be done until the child became older. She has always been incontinent. Her movements are of a ribbon-like character but well formed. There are no urinary disturbances, and the child had always been well otherwise.

The family history was negative for any congenital deformities. Except for the surgical condition, the examination of the child revealed nothing abnormal.

Under anaesthesia the child was examined and the following condition found: There is complete closure of the anus with a small dimple. In the left buttock about an inch lateral to the anus there is an old scar. The vaginal opening is quite small. After dilatation by graduated sizes of proctoscopes the vagina was found to be well formed and that opening into it at its most distal portion, was the end of the rectum. The perineum seemed well formed, but somewhat scarred and there also were apparently present the anal sphincter muscles. There is therefore a loss of about an inch of the distal end of the rectum with a complete closure of the anus and the opening



of the rectum into the most distal portion of the vagina. The tissue comprising the lower surface of the vagina and the anterior surface of the rectum seem solid and thick.

They had here a real congenital recto-vaginal fistula with imperforate anus, an entirely different type of condition from that found in the traumatic cases in adults. In this case a simple plastic procedure would probably fail because of the great distance between the end of the rectum and the intended anal opening. It would be necessary here to mobilize the rectum for a considerable distance so as to gain at least one and one-half to two inches in length to be able to bring it out through a newly formed anus. Therefore the following operation was performed under general anæsthesia. In the lithotomy position, the rectum was filled with plain gauze to prevent discharge of any fecal material. The patient was turned into the right Sims' position. A circular incision was made around the inner circle of the imperforate anus. A second incision was made in the median line to a third of the distance up the sacrum, beginning just posterior to the sphincter muscle. The dimpled skin of the imperforate anus is then removed and the posterior incision deepened downward to the perirectal fat and to the sacrum itself. Care taken not to incise the posterior portion of the external sphincter muscle; thus a bridge of tissue comprising skin and muscle was left between the circular raw area within the external sphincter muscle and the inferior portion of the sacral incision. The coccyx was simply a small nubbin of bone and it was necessary to remove about three-quarters of an inch of the distal portion of the sacrum together with the nubbin of coccyx. The rectum was identified and by fine and digital dissection the portion immediately beneath the sacrum was freed from the surrounding tissue and a tape placed around it. Using this for traction and with the finger of an assistant within the rectum, the distal portion of the rectum was then completely freed. About one and one-half inches from the anal opening it was found that the rectum was tightly adherent and pulled towards the left buttock by a firm fibrous band probably due to the patient's former operation. This had pulled distally a blind pouch forming a "Y", the blind pouch arm of the "Y" being much shorter than the other. This was freed. Following this, by finger dissection, a line of cleavage having been found, the anterior portion of the rectum was freed from the posterior vaginal wall and the distal end of the rectum was then brought out into the posterior wound. Grasping the open end with Allis clamps the rectum was now pulled downwards through the opening made through the anal sphincters, a good layer of muscle having been preserved posteriorly. The rectum was pulled out at least three quarters of an inch to allow for future shrinkage and sutured to the skin by interrupted chromic. The posterior wound was then closed in layers after two small cigarette drains were placed on either side of the rectum into the depths, using plain and chromic gut for the deep sutures and silk for the skin. The patient was then placed in the lithotomy position and the anterior free edge of the posterior vaginal wall sutured by interrupted chromic to the fourchette. A small vaginal tampon inserted and the gauze previously placed into the rectum removed. Dry dressings applied.

The post-operative course was uneventful.

*First day.*—Except for a moderate amount of shock with weak pulse, the patient stood the operation well. Condition this morning is satisfactory. She has voided spontaneously. Vaginal tampon removed. The patient is given tincture opii deodorata mms. 2 t.i.d., and is put on a constipating diet.

*Second day.*—General condition excellent. Pulse of good quality. Is voiding without difficulty. Sacral wound dressed; found to be clean. Both cigarette drains removed.

## CONGENITAL RECTO-VAGINAL FISTULA WITH IMPERFORATE ANUS

Small piece of rubber tissue placed between skin openings to take care of slight sero-sanguinous ooze. Pouting mucous membrane of rectum which was pulled through the sphincters appears in good condition and has not retracted. While cleansing around it a large amount of gas was passed.

*Fifth day.*—General condition excellent. T.P.R. normal. Is still passing gas per rectum—but intentionally has had no movement. Wound dressed. Is healed by primary union. Sutures removed. Several of the chromic sutures holding rectum to the cutaneous junction of anus have worked themselves loose and are removed. While there has been some retraction of the mucous membranes there is still definite protrusion. The vaginal plastic on cursory examination is in good condition.

*Thirteenth day.*—The recto-mucous membrane at the left side appears to be somewhat redundant, and bleeds rather readily. The mucous membrane on the right side has grown to the cutaneous edge perfectly. Patient has been getting large amount of mineral oil for the last forty-eight hours. This A.M. some oil and gas escaped from the rectum. A No. 10 curved rectal dilator introduced without difficulty for a distance of two centimetres, when it struck hard fecal material. Following this a No. 11 similar instrument inserted for about four inches without difficulty and then a soft rectal tube introduced and two ounces of olive oil instilled, to be retained. Following this there were two or three bowel movements in a few hours.

*Thirtieth day.*—*Final note:* The sacral wound has remained healed. Around the muco-cutaneous junction posteriorly there are two small ulcerating areas. The mucous membrane of the rectum has shrunk back, but is tightly attached to the skin. There is no protrusion and no retraction. No. 11, 12, 13, solid curved rectal dilators are introduced—the first two without difficulty, the last fitting rather tightly. There is unquestionably a certain amount of nerve control of the sphincters, but not by any means a complete one. A process of education will have to be entered on.

The posterior vaginal septum is firmly healed both laterally and to the fourchette posteriorly—so that no fecal material enters the vagina. A small perineal body is present.

*Follow-up note:* She has returned to the hospital at first every two weeks, and then once a month, for rectal dilatation, and at present rectal dilators No's. 11, 12, 13, 14, are introduced without any difficulty and without any bleeding. She has absolute sphincteric control and daily normal stool. The floor of the vagina, as well as the sacral wound, are well healed and the child is normal in every way.

DR. HENRY W. CAVE referred to a patient, presented before this Society three years ago, who had been operated upon for practically the same condition with excellent results. The patient was a girl twelve years of age who within about two and a half months after operation had complete control. The sphincter muscles were not around the lower end of the bowel, as it lay at the entrance of the vagina, but were back in their normal position nearer to the coccyx and superficial to the levator and muscles. Doctor Pickhardt's patient presented apparently an opening into the side of the buttocks; this occasionally happens. It is simply a prolongation of the already malformed rectum. Various abnormalities have been recorded of the lower end of the bowel, some emptying into the urethra, bladder, vagina, body of the uterus or into the posterior urethra. These interesting cases are more common than is generally believed. There is an anorecto-malformation in every five thousand births. Pascal reports a patient who gave birth to three children and neither she nor her husband, nor her physician knew until many years after the birth of her children, that she had a vaginal anus.

## CARDIOSPASM WITH DIVERTICULUM OF LOWER ŒSOPHAGUS

DR. MORRIS K. SMITH presented a case of deep pulsion diverticulum of the œsophagus associated with cardiospasm. This case he had already reported in *ANNALS OF SURGERY* for December, 1928, p. 1022. From a review of the literature he felt that there was little evidence that such diverticula were of clinical importance. A few other cases have been recorded of diverticulum associated with cardiospasm. It seems possible that they may serve as foci of irritation, but this is not proved. The treatment when associated with cardiospasm is that of the cardiospasm. Attempts to remove them are not feasible.

## EXTIRPATION OF PHARYNX AND LARYNX FOR CARCINOMA

DR. HERMANN FISCHER presented a man who was admitted to the Lenox Hill Hospital July 28, 1929. He had had difficulty and pain on deglutition for about three weeks before he was seen. On swallowing the food seemed to meet an obstruction very high in the neck. His general condition was good. He had lost some weight. His appetite, however, was fair, but he was greatly annoyed by the difficulty of deglutition. His breathing was unobstructed and his voice was normal. Thoracic and abdominal organs negative. Blood examination showed 5,800,000 red cells, 90 per cent. hæmoglobin. Urine contained some albumin and a few hyaline casts. On the posterior wall of the larynx was a broad sessile tumor. It was round, attached to the posterior wall of the larynx with a broad base. A piece was removed for microscopical examination which proved to be a squamous-celled epithelioma.

July 30, 1929, a typical total laryngectomy and resection of the lateral walls of the hypopharynx and the upper part of the œsophagus was done. After the larynx was removed, only a small portion of the posterior wall of the hypopharynx and the upper portion of the œsophagus was left. The lateral edges of the hypopharynx and of the upper œsophagus were united with the edges of the skin incision. The stump of the trachea was fastened to the skin and a tracheotomy tube inserted into the trachea and an Einhorn tube into the stomach through the œsophageal opening above and behind the tracheal stump for feeding.

The patient made an uneventful recovery and left the hospital August 13, 19 days post operat., with a small fistula of the pharynx above the hyoid bone and the œsophagus fistula above the tracheotomy opening. By careful feeling through the œsophageal tube he was kept in a fair condition of nutrition.

He returned to the hospital October 16 for a plastic operation.

The condition was then as follows: There was a small fistula in the median line of the neck situated just below the hyoid bone; if he swallowed, a small amount of saliva trickled out of it. Below this fistula a strip of the posterior wall of the pharynx of about one-half inch in breadth firmly united with the skin of neck extended down to the œsophageal opening just above the tracheotomy opening. A new œsophageal tube was formed in the following manner: Under local anæsthesia combined with pernoction intravenously, an incision was made on either side of the pharyngeal wall through the skin beginning one inch above the pharyngeal fistula and ending below the œsophageal opening just above the tracheotomy opening. The two skin flaps were mobilized, formed into a tube and united in the median line with silk sutures. After this skin tube was formed, the skin on either side of

neck was dissected loose from the fascia and drawn over the tube and united by silk sutures in the median line. Before the skin tube was fashioned an Einhorn duodenal feeding tube had been inserted into the stomach and let out from the mouth. By means of this tube the patient was fed every two hours.

He made a good recovery and left the hospital two weeks after admission. During his stay in the hospital a small fistula formed at the top and the bottom of the incision. From here small amounts of fluid would escape. A few silk sutures escaped also through the lower opening. Today he eats and swallows solid food of every description without any difficulty, has gained fifteen pounds and feels perfectly well.

## ŒSOPHAGEAL OBSTRUCTION

DR. NATHAN W. GREEN read a paper with the above title for which see page 214. In illustration of his paper Doctor Green presented a series of five patients, as follows:—

1. A woman, aged nineteen years, who was admitted to St. Luke's Hospital July 18, 1928, suffering from dysphagia, consequent upon having swallowed by mistake a small mouthful of concentrated nitric acid five weeks previously. She was given milk to drink and within three-quarters of an hour her stomach was washed out. She vomited when she drank the milk. Three days later the mucous membrane of her mouth "peeled." She was unable to swallow for five days. There was very little pain. After the first five days she could take fluids slowly but no solids or semisolid foods. In the few days before admission she was having a great deal of trouble getting fluids down. For two days after the accident she spat up considerable blood. X-ray examination on July 18, 1922, showed delay in the upper portion of the œsophagus and in the episternal notch. "The findings are those of constriction of the œsophagus."

*Operative Procedure.*—Under ether anæsthesia an œsophagoscope was passed. It encountered resistance a little below the upper sphincter of the œsophagus. Here a contraction was seen. A bougie was then passed through this and the œsophagoscope advanced further. A bougie was then passed to a length of eleven inches. The œsophagus was very red and bled easily. It had the appearance of a granulated surface in places. She was discharged July 22, 1922, improved. She was readmitted July 25, 1922, with the following note:—Patient left the hospital three days ago. At that time she had considerable difficulty in getting fluids down. At the present time they go down quite badly. Solid or semisolid foods do not go down yet. There has been practically no pain. No hematemesis.

On the next day, July 26, 1922: Under local anæsthesia a Kader gastrostomy was done. On August 18, 1922, under ether anæsthesia, the Abbe string-sawing operation was done, using as the advancing bougie one of the Billroth type. @ 38 F. Seven days later a large sized Billroth bougie was drawn up by a strong string swallowed previously and brought out through the mouth. She was discharged improved August 30, 1922. A bougie was passed every few days after discharge from the hospital until June, 1923; then about every two weeks till September, 1923; then every month until April, 1924. Then she went till August, 1924; was again bougied in September, 1924 and November, 1924. No *bouginage* since November, 1924.

March 24, 1925, Dr. LeWald made the following note: "A thick barium mixture passes readily through the œsophagus and shows no tendency to

pocket in the region of the stricture previously noted about one month after the swallowing of the nitric acid."

She has been well since that date.

2. A boy, aged two and three-quarter years, who was admitted to St. Luke's Hospital February 23, 1915, with the history that he had swallowed lye five months previous to admission. On admission he could only swallow fluids. On March 5, 1915, he was transferred to the Surgical Service, and an œsophagoscope was passed, which revealed a stricture through which graduated bougies could be passed through the 'scope. The patient was then returned to the ward for further treatment by dilatation. A gastrostomy was not necessary. May 4, 1915, the œsophagoscope was again passed and the stricture 10 inches from the upper teeth was dilated to a bougie 6 millimetres in diameter. Again on May 22, 1915, in the operating-room the œsophagoscope was passed and gradual dilatation with bougies up to 32 French carried on. On May 31, June 8, 15, 28, July 5 and 12, 1915, he was dilated up to 32 F bougie in the Ward. July 17, 1915, he was discharged improved.

On August 14, 1917, at the age of five years he was readmitted to St. Luke's Hospital. The chief complaint at that time being "vomiting." Upon drinking milk he "vomited" immediately and continued doing so at intervals. On August 24, 1917, the lower end of the œsophagus where the stricture lay was dilated with a Lerche's dilator under light ether anæsthesia to size 32 F. He was discharged August 26, 1917, improved. 36 F. bougie was passed for the last time in December, 1923. He has since that time been well.

3. A man, aged forty years, who was first seen at the Memorial Hospital about May 26, 1924, with dysphagia and regurgitation. X-ray examination is said to have indicated a defect at the lower end of the gullet suggesting a gastric carcinoma at the cardiac end of the stomach.

A gastrostomy was performed at the Mountainside Hospital, Montclair, N. J., June 4, 1924. He was referred to the Memorial Hospital again after the gastrostomy. Here he had two cycles of X-ray treatment. The first one in August and September, 1924, of two anterior and two posterior of fifty minutes each and the second one, in December, 1925, and January, 1926, of two anterior and two posterior of thirty minutes each to cardia. His weight on September 10, 1924, was 132 lbs. The X-ray taken at the Memorial Hospital appeared to confirm the opinion that the patient had obstruction at the cardiac end of the œsophagus, probably involving the fundus of the stomach and extending up to the cardiac end of the œsophagus. April 15, 1925, an olivary bougie about 34 F. was passed on a string which was pulled taut through the mouth and gastrostomy opening right through the entire extent of the œsophagus and the stomach. In November, 1925, the history states that sometimes he could swallow and sometimes he could not. In December, 1925, as he still was unable to swallow he was referred to the X-ray Department (Dr. Herendeen) for treatment. In March, 1926, he tried to eat by mouth, but could not "seem to get it down." May 12, 1926, an œsophageal bougie was passed by the Abbe string sawing method without any anæsthesia. The bougie measured 4 millimetres in diameter. Wassermann was negative.

July 28, 1926, the Abbe string sawing operation was repeated. On September, 1926, his œsophagus was again dilated with a large bougie. On October 20, 1926, it was dilated again with olivary bougie No. 24, passed by the aid of a swallowed string. On August 3, 1927, he was eating well by mouth and his weight was 137 lbs. On September 7, 1927, he was eating everything by mouth. On October 30, 1929, his weight was 141 lbs. and

he was working part time as a carpenter. September 17, 1924, gastric contents showed free HCl 60. Total acidity 80.

This case illustrated obstruction due to an inflammatory mass and probably to extensive or multiple ulcers of stomach and œsophagus simulating carcinoma of cardiac end of stomach and of œsophagus.

4. A woman, aged fifty-six years, was admitted as a private patient to St. Luke's Hospital May 7, 1928. Her chief complaint was that she felt a "bag" in her neck and she had to press it to empty it. A piece of meat nearly choked her 3 years ago (dysphagia). She had lost 25 pounds in the past three years. She felt well and strong and was glad to be reduced in weight. In the neck she said she felt a sac one inch about the collar bone on the right side. X-ray examination showed a large diverticulum about three and one-half inches long. May 9, 1928, an œsophagoscopy was done under local anæsthesia. The scope was passed and the diverticulum located and painted with methylene blue, to identify it later. May 10, 1928, the sac was packed with gauze soaked in 1 per cent methylene blue. It was then dissected out through the neck under local anæsthesia and removed in one stage (this was not advisable although the planes of the neck before opening sac were packed with iodoform gauze. Liquids came out through the neck May 16, and continued doing so until May 25. On May 30, 1928, the patient's weight was 112 pounds. On June 21, 1928, her weight was 118 pounds. The patient was discharged June 21, 1928, improved. August 6, 1928, she was discharged as cured. She now swallows without any difficulty (November 27, 1929) and the X-ray picture shows no pouching.

5. A woman, aged forty-four years, was admitted to St. Luke's Hospital December 6, 1928, with a history of having had some difficulty in swallowing for ten years. This has progressed until recently; she has had difficulty even in swallowing liquids. December 7, 1928, an œsophagoscopy was done. The gullet was found to be dilated and pale pink. The cardia did not open or shut even on forced respiration. The cardia was dilated with a Lerche dilator. December 12, and 28, 1928, May 16, June 21, September 30, October 14 and November 13, 1929, large sized olivary and blunt bougies were passed. (Seven times in 11 months.) On X-ray she presented the shadow of a gall-stone and since presenting her before the New York Surgical Society Doctor Green has operated upon her and removed a thickened white gall bladder containing a mulberry shaped gall-stone.

DR. FRANZ TOREK said that besides the operative successes in carcinoma of the middle portion and at the cardia mentioned by Dr. Green there have been three successes in the upper third reported, one by Küttner, one by Sauerbruch, and the third by Lotheissen. There is no follow-up in Küttner's case, and Doctor Torek had not heard of the final result in Sauerbruch's case. The patient of Lotheissen died five months after operation of some cause which had nothing to do with the original disease. These three cases in the upper third of the thoracic œsophagus were all operated from the neck, and it is remarkable that Lotheissen's case should be reached from the neck because he says that the disease extended almost to the bifurcation of the trachea. In regard to diverticulum, Doctor Torek said it was his custom to operate by the one-stage method. The risk can be overcome by care in the suturing, using fine ligatures, fine needles, and an accurate technic. It is important that the excision of the diverticulum be made slightly distal to its neck so that

after the first row of sutures has been inserted, the second one can be placed without diminishing the lumen of the œsophagus. As regards the difficulty of finding the diverticulum, this may often be overcome by directing the patient, who is under local anæsthesia, to strain. This act will often cause the diverticulum to be blown up and to stand out like a little balloon.

DR. HOWARD LILIENTHAL regarded a high œsophageal diverticulum as invariably a source of danger. It spills and may produce aspiration pneumonia with lung abscess. He had one patient with repeated lung abscesses the cause of which was unrecognized. Finally, on sending her to Dr. B. S. Oppenheimer because of a mild Graves' disease, it was discovered that she had a diverticulum of the upper part of the œsophagus. There is little doubt that overflow from the diverticulum caused the lung suppuration. There is one method of treatment worth considering in these cases; it is that of Von Wildenberg. In operating for diverticulum of the œsophagus, he anchors its fundus firmly to the upper part of the wound so that the opening is the lowest part. It grows there and the diverticulum becomes non-existent, or so perfectly drained that nothing can happen.

Another point about operation, and in regard to Doctor Green's mention of œsophagogastrostomy. Doctor Lilienthal had tried this twice and actually accomplished it only once. In one patient it was impossible to mobilize the stomach and the patient died as a result of the operation. The other lived for seven or eight days and then died of pneumonia. The œsophagogastrostomy functioned perfectly and the patient could swallow fluids with ease after the operation. Autopsy showed no obstruction and no leak.

Doctor Lilienthal did not think carcinoma of the upper thoracic œsophagus should be removed in a one-stage operation. It was better to paralyze the diaphragm first. The method is to expose and mobilize the œsophagus by posterior mediastinotomy. The phrenic nerve can be nicely exposed upon the pericardium and upon pinching it with forceps the diaphragm will immediately become flaccid. The fundus of the stomach is then drawn up through an incision in the diaphragm and the œsophagus divided above the new growth. An incision is then made in the fundus of the stomach and into this is drawn the upper segment of the gullet and the stomach is anchored to this structure by a few sutures.\* If his patient had not died, Doctor Lilienthal had intended at a second stage to work from below, pull the diseased part of the œsophagus down and resect it at the cardia. The operation of œsophagogastrostomy is well worth considering in these cases; it is not a particularly dangerous operation compared with primary resection, but all these procedures have a high mortality. Even if one enters the pleura it does not matter; put a piece of rubber dam against the rent and on removing the dam a few days afterward the lung will be found firmly adherent to the pleural wound. Œsophagogastrostomy is a side-tracking operation and may be compared to ileocolostomy. Doctor Lilienthal felt that repeated experi-

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\* For full description see Lilienthal's Thoracic Surgery. Saunders, 1925.

ence would better the chances for recovery. He foresaw the time when it will be done in inoperable carcinoma of the cardia in preference to gastrotomy. The patient would be able to swallow with comfort instead of being unesthetically fed through an abdominal wound.

DR. HERMANN FISCHER, referring to cicatricial stricture of the œsophagus, said that there are cases in which it is impossible to enter the stricture from above in order to dilate it. At the present time, when œsophagostomy has been developed to such a high degree, such cases are comparatively rare; however, they do occur. Under those circumstances, the surgeon tries to pass through the stricture from behind through a gastrotomy opening, but even this procedure may fail. The only way out of this difficulty is either to leave the patient with a permanent gastrotomy, or to do an ante-thoracic œsophagoplasty by skin flaps, a procedure which is difficult and often subjects the patient to several operations before the desired result is accomplished. There is a third choice of procedure which Doctor Fischer resorted to in an emergency in June, 1910, which he described as follows:

A boy three years old, was admitted to the Lenox Hill Hospital. A few weeks before admission he had swallowed some lye by accident. A tight œsophageal stricture had developed in consequence and the boy was unable to swallow even water. All attempts to pass a bougie, no matter how small in calibre, had been fruitless; therefore a gastrotomy was performed. Some time after the establishment of the gastrotomy, renewed efforts were made to enter the stricture, however, with no success. An attempt was then made to flush a thin silk-thread through with a catheter inserted into the pharynx through one nostril after the method advocated by Dunham, but this also failed. A last attempt was made under narcosis to pass a bougie from below through the gastrotomy, which, however, was also in vain. The patient was therefore fed through the gastrotomy exclusively and unfortunately stood this feeding very badly. He was losing ground steadily and rapidly and suffered from gastrointestinal disturbances with high temperatures which recurred although the utmost care was exercised to regulate his diet. The following procedure was thereupon carried out:

Under Meltzer-Auer intratracheal insufflation of the lung the thorax was opened in the eighth intercostal space giving ample access to the lower part of the œsophagus and the diaphragm. The pleura covering the œsophagus was split, both vagi nerves were carefully isolated from the œsophagus and the latter was bluntly dissected out of its bed by means of forceps. A loop of loosely folded gauze was put around the œsophagus. By carefully pulling the œsophagus upward by this loop of gauze it was loosened all around its attachment to the diaphragm, a pair of anatomical forceps was pushed through the layer of diaphragmatic pleura and peritoneum, and thus the peritoneal cavity opened. The stomach was now carefully pulled into the thoracic cavity until a point was reached about 7 centimetres below the point of entrance of the œsophagus. The pleural cavity was now carefully packed off and a transverse incision made between two silk sutures into the cardia, three centimetres below the entrance of the œsophagus. Through this incision a ureter catheter armed with a stylet was inserted. The stricture was then easily passed from behind and the catheter led out through the mouth, where it was secured by a clamp. A long curved dressing forceps was now inserted into the gastrotomy opening, the lower end of the catheter was



caught and pulled through the gastrostomy. The incision into the cardia was closed with two rows of silk suture, and the stomach replaced into the abdomen. The thorax-wound was closed in the usual manner.

The operation was not difficult and was accomplished in 45 minutes.

This operation was done when intra-thoracic surgery was still in its beginning. It was the first operation on the human being that Doctor Fisher had attempted under intra-tracheal anæsthesia and the assisting personnel had not sufficient experience in handling the apparatus. While closing the thorax, the patient commenced to react and it was necessary to give him more ether. By wrong handling of the apparatus a few drops of ether were blown into the lung which caused a subsequent pneumonia from which he died.

With the present-time large experience in intra-thoracic operations and the modern method of positive pressure narcosis in intra-thoracic surgery, this operation is simple and safe and should be given a trial in these difficult cases, before an antethoracic œsophagoplasty is considered.

The operation was described in *Surgery, Gynecology and Obstetrics*, vol. 12 and 13, 1911.

DOCTOR GREEN, in closing the discussion, said that although Doctor Torek's description of the one-stage operation in œsophageal diverticula in which the sac is amputated distally from the neck, was very interesting, he had seen disaster follow such attempts and preferred the two-stage operation, even if it erred on the side of slowness. He regarded it as a more uniformly safe procedure. Referring to Doctor Lilienthal's mention of Van Wildenberg's method of stitching up the diverticulum, the speaker was conversant with it and was glad it had been referred to in the discussion. Doctor Lilienthal seemed to regard a gastrostomy as distressing, but this was not usually the case if it were done according to the Janeway technic. It has been frowned upon by some because it appeared to be a more extensive procedure, but it appeared to be safer in the end than a gastrostomy done by the Stamm-Kader method. Doctor Fischer's description of making retrograde catheterization was helpful and should be borne in mind in case such a contingency should arise.

# TRANSACTIONS

OF THE

## PHILADELPHIA ACADEMY OF SURGERY

STATED MEETING HELD OCTOBER 7, 1929

The President, DR. ASTLEY P. C. ASHURST, in the Chair

CALVIN M. SMYTH, JR., M.D., Recorder

### DUODENAL ULCER COMPLICATING APPENDICITIS

DR. HUBLEY R. OWEN presented a man, aged thirty-eight years, who was admitted to hospital May 31, 1929, with the chief complaint of acute pain in the abdomen. Twenty days before admission he had had sudden pain in his abdomen which was treated by his family physician and improved. Forty-eight hours prior to admission he took two doses of magnesium sulphate following which the pain became aggravated and he was admitted to the hospital. On admission the patient showed evidence of having very acute abdominal pain. He complained of persistent nausea and vomiting for the last forty-eight hours. His entire abdomen was rigid and exquisitely tender. There was no abnormal breathing. Knees were flexed on the abdomen. The temperature was 103 by axilla; pulse 140; respirations 31. No leucocyte count was made. Operation revealed a general peritonitis. The appendix was readily accessible and was removed. Three tubes and one cigarette drain were inserted; one tube leading to the floor of the pelvis.

The patient's progress, following the operation, was entirely uneventful. He continued to improve until fifteen days after operation when he was seized with severe generalized abdominal pain which was more severe in the epigastrium. There was board-like rigidity.

The leucocyte count showed 20,000 per centimetre with 88 per cent. of polymorphonuclears; lymphocytes 7 per cent.; transitionals 5 per cent. His temperature, which at 8 A.M. had been 98, rose to 103; and pulse, which at 8 A.M. had been 80, at 5 P.M. was 140. At operation an incision was made to the left of the mid-line in the epigastrium. The upper abdomen was a mass of recent adhesions. The duodenum presented a small perforation of apparently an acute ulcer. The ulcer was encircled with a purse-string suture and a piece of omentum was sewn over the anterior portion of the duodenum. The upper abdomen was drained. At the time of the second operation there were eight drainage tubes—one to either renal region; two in the region of the appendix; two in the region of the liver; and two supra-pubic.

The patient had somewhat of a stormy convalescence from his second operation, but was finally discharged from the hospital thirty-seven (37) days after his second operation. It is interesting to note that there was absolutely no history prior to the operation of symptoms suggesting gastric or duodenal ulcer nor has he had any symptoms referable to his abdomen since the operation.

The speaker remarked that the association of sub-acute and chronic disease of the appendix with lesions of the upper abdomen is well recognized. Gastric and duodenal ulcers, gall-bladder disease, pancreatic disease and lesions of the liver may complicate appendicitis. Acute infection of the gall-bladder and acute lesions of the liver are not uncommon complications of acute appendicitis. Acute manifestations of gastric and duodenal ulcers

are apparently rare complications. Rupture of the duodenal and gastric ulcers complicating acute appendicitis is seldom mentioned in the literature. Subphrenic and subhepatic abscesses and abscesses of the liver itself are far more frequent complications of acute appendicitis, than is rupture of gastric or duodenal ulcer. Abscess of the liver probably occurs as a direct transmission of bacteria through the lymphatics or through the portal vein. Ulceration of the duodenum secondarily to acute appendicitis is probably a blood stream infection due to septic emboli. Moore, quoted by Royster, reported a case of perforation of gastric ulcer during an attack of acute appendicitis (*Glasgow Medical Journal*, April, 1923). Zweig assumes that duodenal ulcer complicating appendicitis is the result of retrograde embolus. Hematemesis may be a post-operative symptom of acute appendicitis. Royster mentions three instances of hematemesis after operation for acute gangrenous appendicitis and states that "undoubtedly in some cases there are erosions of the gastric mucosa or even acute ulcers which heal without organic remains." Dielafoy, quoted by Royster, mentions having found ecchymotic patches in the stomach mucous membrane produced, he says, by appendiceal toxins, and the hæmorrhage is precipitated by evident ulceration of the arterioles ramifying under the muscularis mucosæ. Woolsey, quoted by Royster, estimated gastric hæmorrhage as occurring in 2 per cent. of cases of appendicitis. Kummel reported a case of acute appendicitis with a hæmorrhage five days after operation. The patient died on the eighth day and an ulcer of the duodenum seven by eleven centimetres was found in the duodenum. He attributed the origin of the ulcer to embolism. Phifer reported a similar case occurring on the second day after operation. He also "judged the hæmorrhage to be from thrombosis and embolism in the intestinal walls."

#### THE ASSOCIATION OF VERTEBRAL FRACTURES WITH FRACTURES OF THE OS CALCIS

DR. J. GERSHON-COHEN (by invitation) remarked that fracture of the os calcis is frequently encountered in the active surgical service of the Graduate Hospital of the University of Pennsylvania. There are various causes described in different kinds of fractures of this bone which have led to multiple and often confusing classifications. Good results in the treatment of these fractures are generally considered to be obtainable in only about 20 to 25 per cent. and the complication which he proposed to deal with here makes the treatment even more difficult.

Six cases are here reported out of a series of sixty-two cases of fractured os calcis treated at the Graduate Hospital during the past five years, in which a fracture of a vertebra resulted from the same accident that caused the fracture of the os calcis. Twenty of the sixty-two cases had X-ray taken of the vertebræ. The remaining six examined röntgenologically were cases with a history of a fall from a height, and all six showed compression fracture of the body of one or more vertebræ. An interesting phenomenon was the absence or relative lack of commensurate subjective symptoms aris-

ing from the vertebral injury, which phenomenon has recently been recorded by Dr. Lever Stewart.

CASE I.—A woman, thirty-three years of age. Colored housewife. Jumped out of a second-story window and landed on her feet. She was admitted to the Receiving Ward of the Graduate Hospital, February 2, 1928, complaining of swelling and pain of the right foot and ankle and slight pain in the sacral region radiating laterally and forward to the right groin. Physical examination was negative except for tenderness along the lumbar spine, with pain in the right groin; swelling of the right foot, with crepitus and tenderness in the right os calcis. Röntgen examination revealed a compression fracture of the right os calcis and a fracture through the anterior superior portion of the body of the second lumbar vertebra. The röntgen examination of the lumbar vertebra was made because of the previous findings in cases of this character and not because the resident physician believed that the subjective symptoms or the physical findings were sufficiently characteristic to warrant a diagnosis of fracture of the bodies of any of the lumbar vertebræ.

CASE II.—A white male, fifty-nine years of age, who fell a distance of approximately twenty feet from a scaffold on which he was working, landing on his feet. He was admitted to the Receiving Ward, May 28, 1927, with a compound fracture of the right tibia and fibula and a fracture of the left external malleolus with pain and tenderness of the left foot. He had no symptoms referable to the spine except generalized pains and aches over the entire body. Röntgen examination of the spine was made, however, and revealed a fracture of the body of the twelfth dorsal vertebra. This patient died forty-six days after admission to the hospital of acute intestinal obstruction which was confirmed by autopsy.

CASE III.—A man, thirty-nine years of age, who fell eighty feet from the scaffold on which he was working. He landed on his feet and was admitted to the hospital July 31, 1924, with swelling of the left ankle and foot and of the right foot. There were no complaints referable to the spine, but nevertheless röntgen examination was made of the spine at the same time the other examinations were made. There was a compressed fracture of the os calcis of both feet along with fractures through the right scaphoid, the fourth left metatarsal, through the internal condyle of the left femur and of the body of the second lumbar vertebra.

CASE IV.—A woman, twenty-eight years of age. A housewife who during a nightmare walked out of a second-story balcony window. After landing, she got up and walked into her house. This patient complained of pain in the right foot and of some back pain, but not enough at the time of the examination to clinically diagnose fracture of a vertebral body. On röntgen examination, a compressed fracture of the right os calcis and of the body of the second lumbar vertebra was found.

CASE V.—A man, nineteen years of age, who fell from a third-story window. He landed on his feet and sustained fracture of his right os calcis, astragalus, both bones of the right leg and the first, second and third lumbar vertebral bodies. His limb injuries were so marked that his back was relatively painless while reclining quietly in bed.

CASE VI.—A man, aged thirty-four years, who fell through an open manhole landing on his feet. A compressed fracture of the right os calcis was present and this alone was treated for two days when he began to complain of some pain in the lumbar region. Röntgen examination then revealed a fracture of the first lumbar vertebra.

The reporter presented these cases to show the importance of having all cases of fracture of os calcis, produced by a fall from a height, examined röntgenologically for vertebral body fractures. In this examination the lateral view of the spine is by far the more important.

DR. WILLIAM BATES remarked that of the sixty-two cases treated in the period of five years, six of them showed this rather serious complication.

If only 10 per cent. of all os calcis fractures were to show this additional lesion, one would still be justified in X-raying the spine of each one of them. However, of the twenty cases that had pictures taken of the spine, six of them showed a crushed vertebra, therefore the percentage immediately rises from 10 to 30 per cent.

In going over the histories of the twenty cases only six gave a history of a fall from a height; the remainder of the X-rays were taken because of multiple injuries and the possibility of spine involvement. The percentage therefore takes an enormous leap in this small series, showing the frequency that a fracture of the os calcis from a fall from a height also had a crushed vertebra.

Recently, two cases had come to the speaker's attention from other services where both spine and os calcis were X-rayed. The os calcis was found fractured and the vertebræ were not found fractured. It will be interesting to have these two cases X-rayed at a later date and the vertebræ carefully measured for the evidence of compression may not develop immediately. In view of this, many of the forty-two cases in this series which did not have a spine X-ray will be asked to return for X-ray studies.

The second interesting point is the comparative lack of symptoms in each one of these cases, which seemed to him that it justified the advocating of a spine X-ray in every suspected fracture of the os calcis.

In the treatment of the compressed vertebræ they have been using the standard Bradford frame. The patient's height is measured and compared with the total length of the frame and the distance from the site of vertebral fracture from the tip of the head of the patient is measured. The Bradford frame is then bent at a point which will immediately underlie the fractured vertebra so that the frame at this point is raised from four and one-half to five inches from the mattress with the rest of the frame resting flat. The patient is kept in this position for a period of one month in an effort to prevent any weight from resting on the anterior portion of the vertebræ. Following this he is fitted with a brace fitting around the pelvis and extending well up on the chest to immobilize the lumbar region. This brace is worn for from three to six months, according to the severity of the compression.

#### PULSATING EXOPHTHALMOS

DR. GEORGE M. DORRANCE presented a lad, sixteen years of age, who was treated by him in Cooper Hospital, Camden, through the courtesy of Doctors Mecray and Buzby.

The patient was injured in an automobile accident in December, 1928. He was admitted to the West Jersey Homeopathic Hospital, where a diagnosis of fracture of the skull was made. He was bleeding from the nose and ears. Approximately three weeks after leaving the hospital, he developed a swelling of the right eye and complained of a blowing noise in his head. He was admitted to the Cooper Hospital on March 5, 1929, suffering from marked pulsating exophthalmos. There was so much œdema of the conjunctiva that the cornea could not be seen. Doctor Crammer, the ophthalmologist on duty, reported that the eye was pushed forward a considerable distance and furthermore, he could distinctly feel an arterial pulse at

the upper angle of the orbit. A bruit was present. Doctor Dorrance saw the patient and concurred with Doctor Crammer's findings.

On the day of the operation, April 30, 1929, he had marked protrusion of the eye and considerable œdema of the conjunctiva. The bruit was most marked on the right side of the head, but could be distinctly heard over the left eye.

Under local anæsthesia the common carotid area was exposed and a Crile's clamp was applied, gradually obliterated the lumen of the artery. When complete obliteration occurred, it was observed that the pulsation in the temporal artery ceased and the bruit likewise disappeared. The common carotid was then ligated with chromic catgut. It was noted that the eye receded slightly after the ligation. One hour after the operation, the temporal pulse returned. On the following day there was a bruit heard over the right eye. The exophthalmos was unchanged.

On May 20, under local anæsthesia, the wound in the neck was reopened with the idea of ligating a number of the branches of the external carotid. In order to determine if there was any reversal of the flow from the external to the internal carotid, clamps were applied to the internal carotid, one to the external and one to the ascending pharyngeal (Fig. 1).

By releasing the clamp upon the external carotid, it was possible to squeeze out the blood from the space between the clamps (Fig. 1-H). On reapplying this clamp, there was no blood in this space. Removing it, the blood under pressure returned in the area. Again all the blood was pressed out of this space and the external carotid clamp reapplied. On releasing the clamp on the internal carotid, the blood returned slowly in the cavity as if there was just a slight reflux. This blood was squeezed out and the internal carotid clamp reapplied. When the clamp on the ascending pharyngeal was removed the cavity refilled very quickly, but at a more reduced speed and pressure than was observed when the external carotid clamp was released.

This proved to the speaker's satisfaction clinically that anastomosis had taken place between the two external carotid arteries and there was a decided flow of blood from the external into the internal carotid after common carotid ligation; in other words, the internal carotid becoming only an additional branch of the external after common carotid ligations.

Having had the experience of hemiplegia developing following the liga-

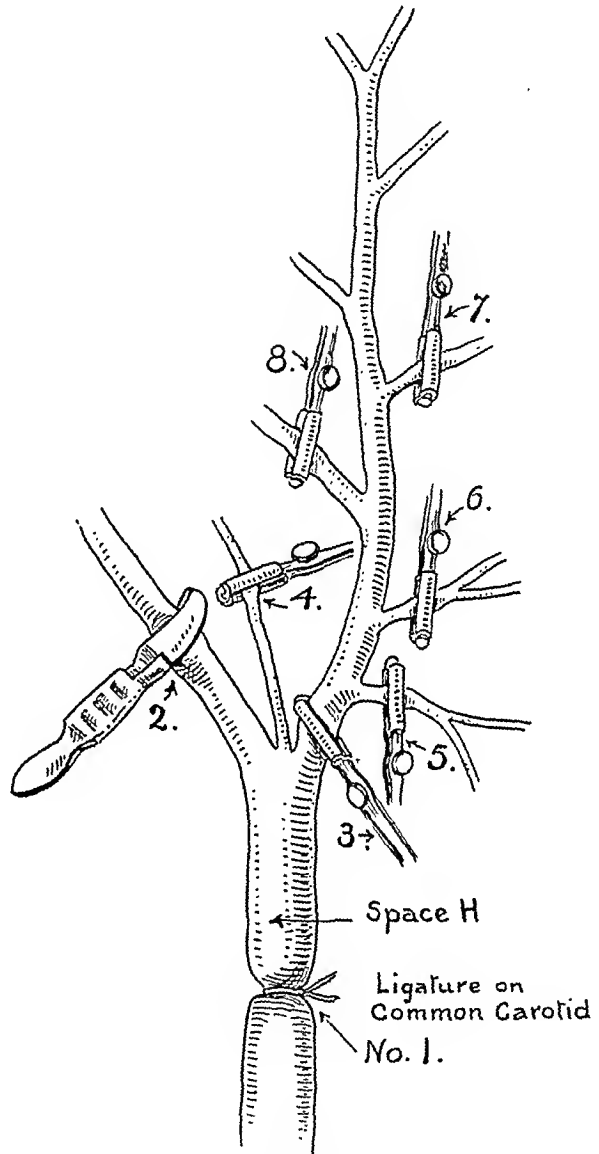


FIG. 1.—The Common Carotid Artery and its branches.

tion of the internal carotid, the speaker ligated the superior thyroid, the lingual, the facial, the occipital, and the ascending pharyngeal arteries and permitted the blood to come through the internal maxillary and temporal arteries, feeling that this would supply sufficient circulation to the brain.

Two months after the operation, the exophthalmus, while present, was so reduced that the patient could see; eye movements were normal; and there was no optic nerve degeneration. Neither the pulsation nor the bruit had returned. Now, on October seventh, which is four and one-half months after operation, the boy states he does not hear any sounds in his head, but thinks the eye has become a little prominent in the last two or three weeks.

Doctor Dorrance remarked that he was presenting this case as an illustration of a method of treating pulsating exophthalmos. It is known from autopsies, that most of these cases are due to communications between the internal carotid artery and the cavernous sinuses. A certain percentage of them apparently undergo spontaneous cures. Many cases reported in the literature have been greatly improved or cured by ligation of the common carotid artery alone. Ligation of the internal carotid artery cures a larger percentage, but unfortunately has a higher mortality; it is often followed by cerebral changes.

The speaker's suggestions in these cases would be as follows: To ligate the common carotid and if this does not cause the exophthalmos to recede and the bruit to permanently disappear, then depending upon the age and the amount of the arteriosclerosis, ligate at one time or in several stages the branches of the external carotid until the bruit disappears.

DR. JOHN H. JOPSON inquired why Doctor Dorrance did not ligate the internal carotid artery at the second operation. Ligation at the common carotid, previously done, had not been followed by any symptoms of cerebral anæmia; and this was presumptive evidence that the circulation through the Circle of Willis was competent. That is, if one did not attribute hemiplegia, which so often followed ligation of the common carotid to the detachment of embolus from the point of ligation, a theory emphasized in this country by Freeman of Denver.

DR. THOMAS A. SHALLOW remarked that up to the present time there is no uniform method of treating traumatic pulsating exophthalmos. Ligation of the common carotid artery on the side of the pulsation has given the best results in most of the successful cases, but even this radical method of treatment frequently fails; the reason for which is attributed, by some, to be due to a canalization of the artery at the site of ligation, thereby reëstablishing the normal flow of blood in the internal carotid artery. This may be the reason for failure in some cases, but it is not so in all cases.

Several years ago the speaker reported a case of bilateral pulsating exophthalmos before this Society. The right eye manifested the cardinal symptoms of this condition, the left eye to a lesser degree. He ligated the right common carotid artery. The bruit and hum immediately disappeared. This observation was made by stethoscopic examination on the operating table. There was a gradual recession of the eye and improvement in all of

his symptoms for several weeks. Then the bruit was again heard by stethoscopic aid, but the other symptoms and signs gradually improved and continued to do so for several months. Then he re-developed the original symptoms. Doctor Shallow concluded that he had established a collateral circulation from the left carotid artery across the Circle of Willis, this conclusion being based on the disappearance of the bruit and hum when the left common carotid was compressed in the root of his neck. He then ligated the left common carotid artery. The patient did not react from this ligation. He developed a high temperature and hemiplegia and died several days later.

At autopsy there was no canalization of the carotid artery first ligated. Sodium iodide was injected into the left common carotid artery above the ligation, and X-ray examination made of the head and the neck. The Circle of Willis was well shown, the right common carotid artery was filled with the solution, showing that the circulation was from above, downward, a reversal of current. He concluded, therefore, that failure of cure was due to reestablishment of the circulation from the other carotid artery. When success is not obtained by ligation of one common carotid artery, the other common carotid should be ligated after a number of months. The speaker hoped that Doctor Dorrance's method will obviate this radical procedure, which is attended with great risk of hemiplegia.

#### TREATMENT OF ANEURYSMS OF THE THORACIC AORTA AND INNOMINATE ARTERY BY DISTAL ARTERIO-VENOUS ANASTOMOSIS

DR. PATRICK A. MCCARTHY read a paper with the above title, for which see page 161.

DR. GEORGE P. MULLER said that attempts to relieve the pain and pulsation which annoys the patient so much are always interesting. A number of years ago he introduced gold wire in a number of cases and sometimes obtained a measure of relief, but it was not always successful. About one month ago, he did one of these operations. The patient had a large swelling causing great pain and annoyance. The operation is simple enough. In the speaker's case the aneurysm came out on the neck and he was somewhat embarrassed on account of the short tense proximal segment. Immediately after the anastomosis he showed the transfer into the jugular vein. This case has been carefully studied by Doctor Wolferth from the cardiologic standpoint. Subsequently the patient went back to Porto Rico; but just before he went home he said that he could feel the aneurysm growing larger and it was on this account that he was anxious to leave. It seemed to the speaker in looking at the various operations for the treatment of aneurysm that the theory is a good one, but it would seem that there is a fly in the ointment. By various sympathetic procedures, he believed that just as much will be accomplished. In Doctor Muller's opinion this always will prove to be an operation of relief rather than cure and eventually these cases will relapse and die just as the wired cases did.



## BRIEF COMMUNICATIONS

### FEMORAL ANEURYSM FOLLOWING OSTEOTOMY OF THE FEMUR WITH SPONTANEOUS OBLITERATION\*

THERE are certain complications in orthopedic surgery that owe their interest to their unusual and rare incidence in the face of what apparently is an inevitable occurrence. Posterior displacement of the distal fragment of the femur with irreparable damage to the underlying popliteal structures is understood and foremost in the minds of third and fourth year medical students. However, transverse osteotomies of the femora for genu varum are often performed, followed by the application of a plaster cast, and if proper weight-bearing alignment is grossly obtained the relation of the divided ends of the bone to the underlying vessels is a matter of little concern.

The object of this communication is to direct attention again to the vascular damage that can be done by malposition of the cut ends of the fragments, particularly following corrective procedures of the type referred to above.

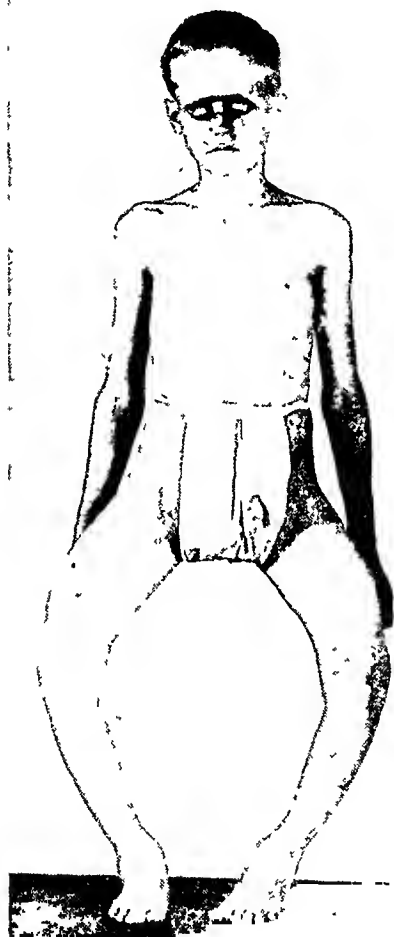


FIG. 1.—Photograph of patient revealing the extreme preoperative deformity (genu varum).

His family history is interesting in that his mother has similar rachitic deformities which have reduced her height to four feet eight inches. His two maternal cousins are in the hospital at this time with similar deformities. Although there were typical skull changes and involvement of all of the long bones, the most marked deformities were confined to his lower extremities. Along with the marked lateral bowing of the femora, tibiae and fibulae, there was an accompanying torsion of fifty-five degrees. The Wassermann reaction was negative.

June 11, 1928, a transverse subperiosteal osteotomy of each femur was performed at the point of maximum bowing which was at the junction of the middle and lower third

\* From the Department of Surgery, Washington University School of Medicine, Barnes Hospital and the Shriner's Hospital for Crippled Children.

## OSTEOTOMY OF THE FEMUR WITH SPONTANEOUS OBLITERATION

of the femur. A plaster spica was applied after the torsion and lateral bowing of the femora were corrected by aligning the anterior spine of the ilium with the midpatellar line when the greater trochanter was rotated medially to its greatest extent. The post-operative X-rays show that a satisfactory correction and position was obtained of the left femur, but there was some overriding of the fragments on the right side. Satisfactory callus formation ensued in each instance.

July 16, 1928, a bilateral osteoclasia of the tibia and fibula was performed. The combined lateral bowing-torsion deformity of the legs was corrected and plaster casts were applied.

August 9, 1928, solid walking plasters extending well up to the ischial tuberosities were applied and the patient sent to his home. At this time, a careful examination revealed nothing abnormal at the operative sites.



FIG. 2.—Röntgenogram taken one month after operation. Note overriding with poor alignment of bones on the side (right) where the aneurysm occurred.



FIG. 3.—Photograph of patient taken two months after operation illustrating the fusiform swelling (aneurysm) at the site of osteotomy (A).

The patient returned to the Out-Patient Department September 5, 1928, and the walking plasters were removed. There was a definite tumefaction at the site of the osteotomy of the right femur. This was three centimetres by four centimetres, fusiform in shape, cystic to the touch and apparently covered only by skin and subcutaneous tissue, not tender, immobile and connected or springing directly from the deep tissues. There were definite expansile pulsations within the tumor that were synchronous with the radial pulse. A thrill could be felt and a bruit could be heard over the entire mass. The mass could be obliterated by compression over its presenting surface. The skin over the extremity was soft,

warm and elastic. There were no demonstrable temperature, color, motor nor sensory

changes present. On palpating the femoral vessels, it was found that the thrill disappeared abruptly when the proximal end of the mass was reached; upon auscultation along the

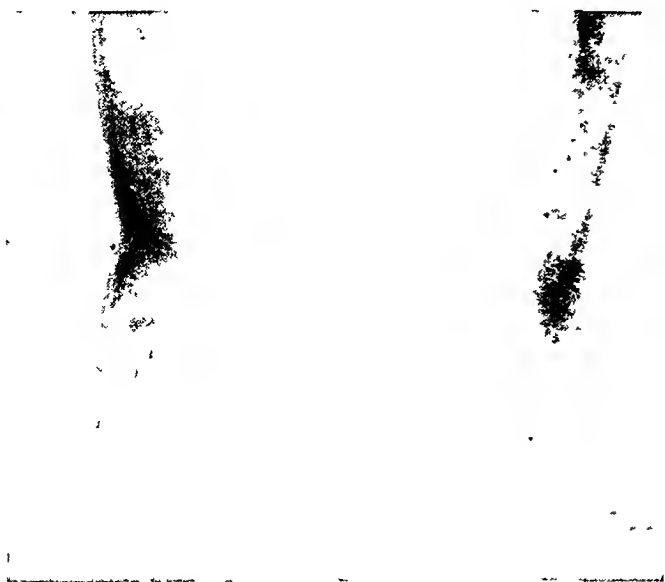


FIG. 4.—Röntgenogram of femurs taken on the same day as the photograph shown in Fig. 3.

A diagnosis of traumatic aneurysm of the femoral artery was made, though the inefficiency of the collateral circulation was a matter of consternation.

The entire extremity was rendered bloodless by elevation followed by the application of a wide elastic bandage from the toes to the right inguinal ligament. A tourniquet was then placed about the thigh at a higher level and the elastic bandage removed. Digital pressure was made at the proximal end of the aneurysm and the tourniquet was removed, restoring the circulation in the femoral and profunda trunks. As blood could only pass into the leg through the anastomoses of the profunda artery with the geniculate and superior genu arteries below, the fact that five minutes elapsed before the gradual descent of a red blush reached the nail beds indicated that the collateral channels, though patent, were hardly adequate at this time.

With this in mind, a special tourniquet clamp was constructed after a pattern described by Matas and applied for fifteen-minute periods twice daily over the proximal portion of the presenting lesion. After four weeks of these "vascular calisthenics," the pulsating mass was definitely reduced in size and a test for collateral circulation at that time revealed the fact that an adequate collateral circulation had been established.

line of the femoral vessels, one could hear the loud bruit for a distance of eight centimetres proximal to the visible lesion. Digital pressure on the femoral artery just distal to the inguinal ligament obliterated both the thrill and bruit. Fluoroscopic examination of the mass revealed a pulsating, fusiform enlargement of the femoral vessel, the wall of which was in close approximation with the edge of the femur. The pulsations of the dorsalis pedis and posterior tibial arteries were similar to those in the unaffected side in every respect. Examination of the heart showed no evidence of enlargement, dilatation nor hypertrophy.



FIG. 5.—Röntgenogram taken seven months after operation demonstrating the correction of the bowing deformity. Note that the sharp edges of bone have been ironed out with a tendency toward correction of alignment.

## SPLENECTOMY IN ACUTE HÆMORRHAGIC PURPURA

This treatment was continued for twelve weeks and at the end of this period, it was difficult to demonstrate the lesion although the bruit could be heard and the thrill was felt on deep palpation. The pulsation of the dorsalis pedis artery was apparently normal.

The patient was discharged with guarded instructions and has been seen in the Out Patient Department at regular intervals. The aneurysm has apparently obliterated itself and undergone complete consolidation.

### SUMMARY

1. A case of traumatic aneurysm of the femoral artery following osteotomy for genu varum is presented.
2. The successful use of the Matas tourniquet for the establishment of adequate collateral circulation is recorded.
3. The non-operative cure of a traumatic femoral aneurysm is presented.
4. A plea is made for a careful approximation of the cut ends of bones following osteotomies to avoid such a post-operative complication as arose in the case presented.

FRANKLIN E. WALTON, M.D.,  
*Saint Louis, Mo.*

## SPLENECTOMY IN ACUTE HÆMORRHAGIC PURPURA

ACCORDING to all text-books and many writers of current literature, splenectomy is contraindicated in the treatment of acute hæmorrhagic purpura. Frequently, such references can be traced to the same source, or one author will quote a preceding one, taking for granted that his opinion, source of knowledge or interpretation of facts is correct. Sometimes by tracing such an accepted view to its beginning other facts may be elicited, which will throw a different aspect on the situation, and entirely change one's conception of preëxisting accepted conclusions.

Previous to 1925, ten cases of acute hæmorrhagic purpura were reported in the literature; splenectomy was performed in each of these patients. One patient recovered, one case was reported the day of operation so the outcome is unknown; eight of the patients died. All references to the contraindication of splenectomy have been made from these cases, the majority of which are in the German literature.

Since 1925 four cases of acute hæmorrhagic purpura in which splenectomy has been successful have been reported. Because



FIG. 1.—Gross specimen of spleen weighing 543 grams.

## BRIEF COMMUNICATIONS

of these successes I became interested in determining, if possible, why operations previous to 1925 had failed, as these failures had resulted in a general pessimistic attitude toward splenectomy. Since splenectomy was successful in four patients, I feel that we should not continue to neglect a possible life-saving measure for other patients without a careful study of the facts.

TABLE I  
*Acute hæmorrhagic purpura*

Date 1929	Hæmo-globin per cent.	Erythro-cytes mil-lions	Leuco-cytes thou-sands	Coagula-tion time minutes	Bleed-ing time minutes	Platelets	Retractility of clot	Transfusions and Splenectomy
9/24	58	3.30	5.85	5	30 +	95,000	None in 24 hours	
9/25								750 c.c. whole bld.
9/26	55	3.20						750 c.c. whole bld.
9/27								750 c.c. whole bld.
9/28	55	3.28				100,000		750 c.c. whole bld.
9/29								750 c.c. whole bld.
9/30	60	4.35			30 +	110,000		
10/1								750 c.c. whole bld.
10/2	65	4.60	6.00		30 +	120,000		
10/4								750 c.c. whole b'd. + splenectomy
10/5	65	4.16			9	135,000		
10/6	60	3.78			10½	115,000		
10/7	60	3.85			7	140,000		
10/8	60	3.72	19.90		6	140,000		
10/11	60	3.91	22.80		2½	180,000	normal	
10/15			21.00					
10/21	62	4.12	12.10			222,000		
10/29	65	3.96	11.20		2¾	210,000		

Of the ten cases in the literature previous to 1925, the only patient who lived was operated on with a hæmoglobin of twenty per cent. and erythrocytes numbering 2,210,000. A transfusion was not given preoperatively, but 700 cubic centimetres of blood was used immediately following the operation. Twelve days later a second transfusion was given. Two of the cases reported

by Whipple<sup>1</sup> were personal communications with no available data except that the condition was acute and splenectomies were performed; both of these patients died. Six of the eight patients who died were all operated on when the blood count was low. In two the erythrocytes were below 2,000,000; in three between 2,000,000 and 2,500,000; and in one 2,600,000. In five of these patients the hemoglobin was below forty-five per cent., and in one it was seventy-four per cent. Transfusions were not used in any of these patients before or after operation. A patient could not be expected to withstand a major operation with a hæmoglobin of ten per cent. or erythrocytes numbering 960,000. In any other type of surgery an operation would not be considered until the blood had improved with the use of one or more transfusions.

In contradistinction to the eight deaths are four recent reports of patients who lived. At the time of operation the hæmoglobin in these patients was forty-six, fifty-five, sixty-eight, and seventy per cent. and the erythrocytes numbered 2,700,000; 3,300,000; 3,400,000 and 3,900,000 respectively. In all of the patients transfusions were used immediately preceding the operation and in two patients transfusions were given one or two days previously. It would seem from such facts that if splenectomy is attempted in the presence of a very low blood count and without preliminary transfusions, a high mortality rate may be expected. If the same procedure is carried out on a patient with a fair blood count and if a transfusion is used just before the operation, an average measure of success may be obtained. If the hæmoglobin and the erythrocytes are extremely low, daily transfusions should be given until the desired level is reached; even then a transfusion just before the operation is very important. The platelet count seems not to be a factor in the surgical prognosis. Of the four patients who recovered, the platelet counts varied from 10,000 to 41,000 just before the operation. The platelet counts in the six patients who died varied between 0 and 90,000.

Splenectomy would seem unwise in an acute stage of the disease with high fever, continued bleeding and an increasing poor condition of the patient, even though the hæmoglobin and erythrocytes are maintained at a fairly high level with repeated transfusions. Splenectomy may be seriously considered when transfusions fail to cause a cessation of bleeding in a patient who is afebrile, and whose blood count and general condition with the aid of transfusions insure a fair surgical risk.

I herewith add a fifth case of acute hæmorrhagic purpura in which the patient recovered after splenectomy.

CASE I.—A man, aged forty-five, came to the Jackson Clinic, September 24, 1929, complaining of bleeding from the gums following the extraction of six upper teeth. The family and past history were unimportant, except for arthritis deformans of eleven years' duration.

<sup>1</sup> Whipple, A. O.: Splenectomy as a therapeutic measure in thrombocytopenic purpura hæmorrhagica. Surg., Gynec. and Obst., vol. xliii, pp. 329-341, 1926.

## BRIEF COMMUNICATIONS

Two weeks previously six upper teeth had been extracted. Unusual bleeding did not occur at the time and the following day bleeding had entirely ceased. A week later oozing of blood began from the site of the extractions, and also from the gum margins of the lower jaw. About this time he pricked the end of one of his fingers with a piece of glass; the finger bled for two hours before it could be stopped. Three days previously purpuric spots appeared on both legs.

The general examination revealed moderate deformity of feet and hands from arthritis deformans, and several petechiæ, many of them 2 millimetres in diameter on the jaw and neck. The gums of the upper jaw at the site of extraction were oozing freely, and there was moderate bleeding from the gums around the lower teeth. A few petechiæ were noted on the chest and arms; there were none on the abdomen and back. The legs from the feet to the groins were covered with petechiæ of varying size with several ecchymoses about 1 centimetre in diameter. The spleen was palpable one inch below the costal margin on deep inspiration.

Laboratory examinations September 24, 1929, showed a hæmoglobin of fifty-eight per cent.; erythrocytes 3,300,000, and leucocytes 5,850. Differential count; neutrophils seventy-nine per cent.; small lymphocytes seventeen per cent.; transitionals four per cent. Coagulation time five minutes, bleeding time thirty minutes plus, platelets 95,000. No retractility of clot in 24 hours. The Tourniquet test was positive. The urine showed a few red blood cells.

Six transfusions of 750 centimetres of whole blood were given in seven days without any effect on the bleeding. The hæmoglobin and erythrocyte count improved and there was a slight increase in the number of platelets. The bleeding time remained unchanged.

The spleen increased in size; it was palpable two inches below the costal margin. Since the transfusions had had no effect on the bleeding or bleeding time, and only slight effect on the platelet count, and as new petechiæ were constantly appearing, it was decided, in view of the patient's good general condition, to perform a splenectomy.

The seventh transfusion was given immediately preceding the operation. The spleen was removed October 4, 1929; it was considerably enlarged, weighing 543 grams. Eight hours after the operation, the bleeding of the gums ceased and did not recur.

The improvement in the bleeding time, platelet count, and retractility is shown in Table I.

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# ANGIOMA OF THE LEG

ONE is ordinarily prompted to report a case presenting unusual features, but I believe the subjoined case is worth recording because it is in every respect true to the classical picture and corresponds exactly to the text-book description. It has the added value of focusing attention on the desirability of extirpating all tumors at the earliest possible moment. Angiomata are benign growths, but there is no telling when they may become locally malignant, or by in-



FIG. 1.—Angioma of leg. Conspicuous swelling on back of right leg.



FIG. 2.—Tumor cut longitudinally. The dark areas are the dilated blood spaces.

vading important structures compromise the function of the surrounding tissues or give rise to extensive hæmorrhage.

CASE.—In May, 1928, Sol B., seven years of age, was admitted to the First Orthopedic Division of the Ruptured and Crippled Hospital, service of Dr. Royal Whitman, for an enlargement of the right calf. When the patient was three weeks old, the parents noticed a thickening in the right calf. This had steadily increased in size so that latterly the right leg was conspicuously larger than the left. The boy had no discomfort in the right leg and was able to walk, jump and run as well as his playmates.

Examination showed a well developed boy who had a swelling in the back of the right leg. The enlargement (Fig. 1) was due to a resistant swelling, about as large as a small orange in the soft tissues of the upper half of the back of the leg. The tumor was superficial to the calf muscle and was not attached to the skin, *i.e.*, it was definitely in the subcutaneous area. It could be moved laterally, but not vertically. It did not pulsate and was not sensitive to pressure. Laterally its outline was fairly distinct, but above and below it tapered gradually so that its limits could not be identified. The mass evidently consisted of soft, elastic tissues. A lateral X-ray film showed a more



or less oval shadow in the upper half of the leg behind the muscles. The bones appeared entirely normal. The swelling was evidently a tumor, but we were not sure of its exact structure and advised its removal.

*Operation, May 7, 1928.*—The operation was performed under a general anæsthetic. A five-inch incision was made in the median aspect of the back of the leg over the

tumor. The mass was readily exposed by retraction of the edges of the skin. The tumor was found to extend vertically beyond the area of the incision, consequently the wound was extended upward to the popliteal space, and downward to a little above the heel until the limits of the tumor were reached. It lay between the muscles and the skin and was firmly attached to the deep fascia. The tumor was approximately pear shaped, the body being above and the stem below. The total length of the tumor was between six and seven inches. The body of the tumor was about two and one-half inches wide and one and one-half inches thick. It was firm and had bluish black streaks due to masses or clumps of veins.



FIG. 3.—Cavernous hemangioma. Microphotograph of representative section. A—Dilated blood vessel. The wall is indistinctly demarcated. B—Dilated thin walled vessel filled with blood clot. C—Lipomatous connective tissue.

The stem was at least three inches long, one inch wide, and one-quarter inch thick. It terminated below in a single vein. Above, the tumor was continuous with a small apparently single vein. On its deep surface the tumor was intimately adherent to the deep fascia over the sural muscles.

The cut surface of the tumor (Fig. 2), demonstrated a stroma composed of numerous blood-spaces with intervening fibrous tissue walls. This is shown very distinctly in the micro-photograph (Fig. 3).

We are apparently dealing here with a tumor which is congenital in origin or started to grow so soon after birth that at the age of three weeks it was distinctly noticeable. As in most cases of cavernous angioma, it grew slowly, but steadily until its size created an offensive difference in the girth of the legs. The firm consistence of the mass and its structure was typical of the cavernous angioma. One very interesting aspect was the easy recognition of the connection with and probable origin from an efferent vein at the lower extremity of the tumor and its emptying into a single vein above. A careful search was made for an anastomosis with deep veins, but none was found. The deep fascia served as a limiting wall effectively separating the tumor from the deep tissues.

This case runs true to form and corresponds to Doctor Ewing's description, that "angiomas are of congenital or early development, slow growth and benign course, and they occur under rather characteristic clinical conditions."

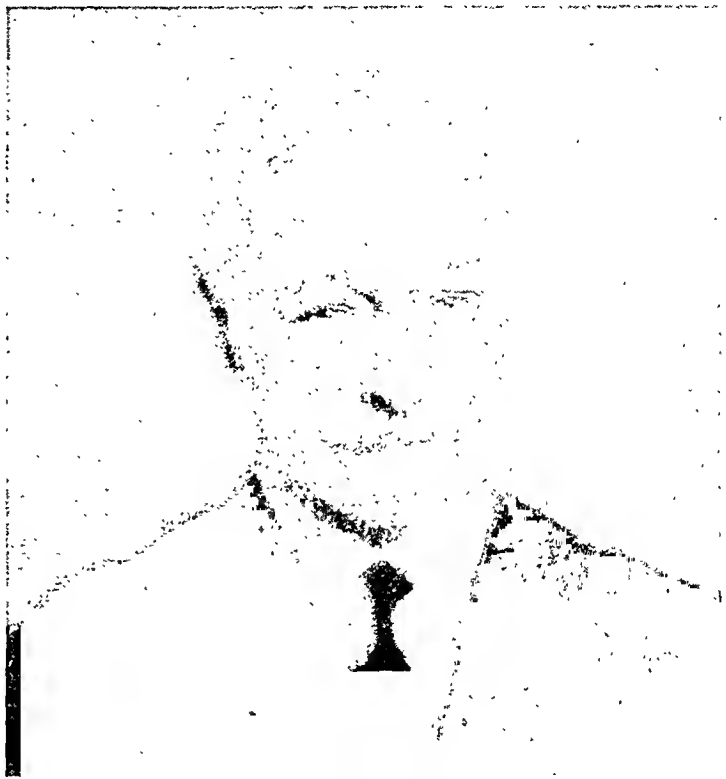
SAMUEL KLEINBERG, M.D.,  
New York.

# MEMOIR

FRANCIS WISNER MURRAY, M.D.

1873—1929

DR. FRANCIS WISNER MURRAY died suddenly in Florence, Italy, on April 12, 1929. He prepared for college at the Cheshire Academy, Connecticut, and St. Paul's School, Concord, N. H. He entered Yale and gained the distinction of receiving a secondary colloquy appointment in both his Junior and Senior years. He received the degree of M.D., at Columbia, in 1880, after which he served for two years as interne at the Chambers Street Hospital in New York. There he was associated with the late Dr. W. T. Bull, at the time Doctor Bull performed his memorable operation of suture of wounds of the intestines. Doctor Murray continued his medical studies on the Continent, attending clinics at Berlin, Vienna and Heidelberg, and on his return became one of the first in New York to specialize in the practice of surgery.



FRANCIS WISNER MURRAY, M.D.

He served as Chief of the Dispensary of the Chambers Street Hospital for two years and was surgical registrar of the New York Hospital from 1884 to 1886. Later he was Attending Surgeon to St. Luke's Hospital and the New York Hospital. His chief activities were at the New York Hospital where he was an Attending Surgeon from 1893 to 1915 and Consulting Surgeon from 1915 to the time of his death. He was always careful and conscientious in the observation of his ward duties and showed exceptional consideration for the welfare of all patients entrusted to his care. His operative results were good and in one period of a six months' service he had over 100 cases of appendectomy without a death. His conservatism stood his patients in good stead and was the outstanding characteristic in his surgical career.

Doctor Murray was Consulting Surgeon to St. Luke's, New York Eye and Ear and other hospitals. He also was professor of clinical surgery at the Cornell Medical School in New York. For three years he served as Surgeon Major in the First Brigade of the New York National Guard.

He was a member of the New York Academy of Medicine, the American Medical and the American Surgical associations, the New York Surgical Society, the Association of Military Surgeons, the Medical and Surgical Society, the Clinical Society, and the International Surgical Society and an associate member of the Surgical Society of France.

Doctor Murray's death has brought sorrow into the lives of all those who were associated with him during his long connection with New York medicine.

EUGENE H. POOL.

EDITORIAL ADDRESS

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## THE CAUSES OF DEATH AFTER OPERATION \*

A STUDY BASED ON EIGHT HUNDRED AUTOPSIES

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OF NEW YORK, N. Y.

FROM THE LABORATORIES OF THE MOUNT SINAI HOSPITAL, NEW YORK

ABOUT four years ago, at a surgical conference at the Mount Sinai Hospital, there was a discussion on the rôle of pneumonia as a cause of death after operation. One of us was asked to investigate a considerable number of autopsies performed on those who had died after operation and to determine the mortality of post-operative pneumonia. In that analysis pneumonia was a not infrequent cause of death. Frank infection, however, was found far more commonly at autopsy than had been anticipated. An impartial survey of a larger material was decided upon because the subject appeared of sufficient importance to warrant it. Furthermore, post-mortem data from other institutions had to be included in order to obtain more comprehensive statistics of the causes of death after operation.

This report is based on 800 consecutive autopsies performed on patients who died after operation at the Mount Sinai Hospital and at two other representative hospitals in New York. The percentage of autopsies performed on patients who died after operation is high enough to warrant acceptance of the figures as fair indices of the causes of post-operative mortality. The investigation was in no way related to the entirely separate matter of operative mortality, but was solely concerned with the question of why patients die after operation. In every instance, the clinical as well as the autopsy record was studied. Undoubtedly, errors have been made here and there in the interpretation and in the evaluation of various factors. The broad conclusions that can be drawn are therefore of greater importance than the precise figures to be presented.

Autopsies on patients dying within forty-eight hours of operation were excluded. These were mainly cases of operative shock and hæmorrhage, operations as a last resort, or minor procedures on patients suffering from greatly advanced lesions, and we found it impossible to determine the relation of operation to the mortality in most of these very early post-operative deaths. All post-mortem examinations that did not appear to be sufficiently complete to establish a definite cause of death were omitted. As a result autopsies limited to an examination of the head or chest were excluded unless an obvious cause of death was disclosed in the limited examination.

\* Read before the New York Surgical Society, January 8, 1930.

Deaths after readmission to the hospital were also omitted unless additional operations were performed. All other cases were listed regardless of how long after operation patients remained alive in the hospitals.

As the analysis progressed we found that the causes of death fell into six categories, and a seventh heterogeneous group:

1. The original disease.
2. Suppuration.
3. Suppuration as a contributing cause, combined with some systemic disease (*e.g.*, generalized arteriosclerosis, diabetes, valvular disease of the heart, chronic nephritis).
4. Suppuration plus pneumonia.
5. Pneumonia.
6. Pneumonia as a contributing cause, combined with some systemic disease as in 3.
7. Miscellaneous, such as embolism, tuberculosis, hæmorrhage, acute yellow atrophy, etc.

Some explanation of the manner in which cases were placed in the different groups is necessary. In a great many instances relatively little consideration was required, for the primary causes of death as disclosed by autopsy were obvious enough. Specifically, whenever there was any doubt as to the rôle of the original disease as compared with infection or a pulmonary complication, the case would be placed in the category of the original disease rather than in any other group. Our purpose was neither to minimize nor to stress the complications of operation but rather to evaluate factors of which we could be reasonably sure.

Death was classified as due to the original disease (Group I) when only the original disease or its extension was disclosed at autopsy. A few examples may be cited: malignancy if the original growth or metastases or complications referable to the tumor were found at post-mortem examination, cases of acute appendicitis or cholecystitis with early peritonitis, pulmonary abscess complicated by empyema after operation, acute osteomyelitis with death from further extension of the disease or from septicemia.

Suppuration (Group II) was termed the cause of death after operation when it was evident and gross at the post-mortem examination and followed operation for a non-suppurating lesion. Purulent peritonitis, gangrene, suppurative septic foci, extravasation of contents of the hollow viscera through suture lines, illustrate the types of lesions classed under infection as the cause of death. If autopsy after an intestinal resection only disclosed a localized plastic peritonitis, the case would not be classified as a death from infection. On the other hand, a frank and undrained collection of pus was termed the cause of death if it were the sole pathological lesion found at autopsy. Cases were placed in Group III when some additional significant lesion was disclosed. Deaths were ascribed to suppuration only when the infection was recent and could be related to the operation or the operative field. Thus a patient who died of pneumonia with complicating

## CAUSES OF DEATH AFTER OPERATION

empyema after an interval operation for appendicitis would be placed in the pneumonia group (Group V) if there were no intraperitoneal suppuration.

In the group of suppuration and pneumonia (Group IV) were placed those cases in which both lesions were found at autopsy and in which it was thought that both were important factors in the cause of death. Group V was reserved for pneumonia as the essential cause of death, just as Group II was reserved for infection as the cause of death. A post-pneumonic lung abscess would be placed in the same group as pneumonia. Pneumonia was classed as a contributing cause (Group VI) when systemic disease was found

TABLE I  
*Causes of Death—800 Cases*

	Number of cases	Per cent
1. Original disease.....	336	42.0
2. Suppuration.....	204	25.5
3. Suppuration plus systemic disease.....	12	1.5
4. Suppuration plus pneumonia.....	32	4.0
5. Pneumonia.....	62	8.0
6. Pneumonia plus systemic disease.....	28	3.5
7. Miscellaneous.....	126 <sup>a</sup>	15.5
	800	

<sup>a</sup> *Miscellaneous causes:*

Cardiac disease and arteriosclerosis.....	34
Embolism and thrombosis.....	25
Ileus (non-peritonitic).....	23
Hæmorrhage.....	16
Renal disease.....	9
Pulmonary tuberculosis.....	8
Duodenal fistula.....	4
Acute yellow atrophy of the liver.....	2
Pulmonary atelectasis.....	1
Ruptured urinary bladder*.....	1
Acute appendicitis*.....	1
Acute pancreatitis*.....	1
Tetanus.....	1

126

\* Unassociated with original disease.

at autopsy and the pulmonary lesion was not extensive—for example, a case of generalized arteriosclerosis and chronic nephritis and a terminal bronchopneumonia. On the other hand a terminal bronchopneumonia was not regarded as contributing to the fatal issue in a case of diffuse purulent peritonitis.

Table I was made without reference to the disease for which operation was performed, and without regard to the presence or absence of infection before operation. It is therefore not as significant as the following table, in which the cases are separated into those in which suppuration was and those in which suppuration was not present before operation.

The most striking feature of Table II is the fact that suppuration is the most common cause of death after operations for non-suppurative disease (39 per cent.). The infection was in the immediate neighborhood of the operative field in the great majority of instances. Occasionally the operative

zone was healed or healing and the suppuration, presumably resulting from operation, had localized in some more distant area. Pneumonia was a much more common cause of death (11 per cent.) in the non-infected than in the infected cases (1.5 per cent.). The great bulk of the patients dying after operations for a suppurative lesion died of suppuration (88.5 per cent.). Of considerable importance is the autopsy: evidence that the primary focus of suppuration (appendix, gall-bladder, etc.) had often been adequately cared for at the operations by excision, drainage, or other procedures. The clinical records not infrequently indicate the assumption that the patients had

TABLE II

Causes of death	521 Non-suppurative cases		279 Suppurative cases	
	Number of cases	Per cent	Number of cases	Per cent
1. Original disease.....	89	17	247	88.5
2. Suppuration.....	204	39	0	
3. Suppuration plus systemic disease.....	12	3	0	
4. Suppuration plus pneumonia.....	22	4	10	3.5
5. Pneumonia.....	57	11	5	1.5
6. Pneumonia plus systemic disease.....	27	5	1	.5
7. Miscellaneous.....	110 <sup>a</sup>	21	16 <sup>b</sup>	6.0
	521		279	

<sup>a</sup> Miscellaneous causes:

	a	b
Cardiac disease and arteriosclerosis.....	29	5
Embolism and thrombosis.....	21	4
Ileus (non-peritonitic).....	19	4
Hæmorrhage.....	15	1
Renal disease.....	8	1
Pulmonary tuberculosis.....	8	1
Duodenal fistula.....	3	1
Acute yellow atrophy of the liver.....	2	0
Pulmonary atelectasis.....	1	0
Ruptured urinary bladder*.....	1	0
Acute appendicitis*.....	1	0
Acute pancreatitis*.....	1	0
Tetanus.....	1	0
	110	16

\* Unassociated with origina. disease.

been making satisfactory progress under such circumstances, until the final picture supervened. In other instances an unsatisfactory clinical course was ascribed to some cause far removed from the operative field (pulmonary, cardiorenal) and undrained collections of pus were disclosed at autopsy. The rôle of pneumonia will be discussed in a succeeding paragraph. In this place, we would stress the fact that suppuration was the direct cause of death in the vast majority of patients who died after operations for suppurative lesions, and that the clinical course not infrequently failed to give clear evidence of the true situation.

An analysis of 500 consecutive clinical records was made in the effort to determine how frequently serious post-operative suppuration was assumed to exist in patients operated upon for non-suppurative disease. Of 113 pa-

### CAUSES OF DEATH AFTER OPERATION

tients who died primarily of suppuration, forty charts record the diagnosis of infection and fifty have final notes indicating the impression that the cause of death was other than infection. Assuming that the diagnosis of infection was made in the remaining twenty-three cases, and with no desire to place the diagnosis of post-operative suppuration on a statistical basis, the conclusion is inevitable that suppuration after operations for non-suppurative conditions was often not under consideration during life. This should not be interpreted as a criticism of clinical diagnosis. On the contrary, a study of the records warrants the statement that the clinical evidences of suppuration were lacking in very many instances. The conclusion of clinical significance to be drawn is that attention must be focused on suppuration in the operative zone as the probable complication whenever patients are not doing well after opera-

### TABLE III

292 *Operations on the Gastro-intestinal Tract*  
(excluding operations for appendicitis)

Causes of death	246 Non-infected cases		46 Infected cases	
	Number of cases	Per cent	Number of cases	Per cent
1. Original disease.....	28	11	43	94
2. Suppuration.....	109	45	0	
3. Suppuration plus systemic disease.....	9	4	0	
4. Suppuration plus pneumonia.....	15	6	2	4
5. Pneumonia.....	30	12	0	
6. Pneumonia plus systemic disease.....	16	6	1	2
7. Miscellaneous.....	39 <sup>a</sup>	16	0	
	246		46	

<sup>a</sup> *Miscellaneous causes:*

Cardiac disease and arteriosclerosis . . . . .	8
Osis . . . . .	8
. . . . .	6
. . . . .	6
Pulmonary tuberculosis . . . . .	5
Hæmorrhage . . . . .	3
Duodenal fistula . . . . .	2
Acute appendicitis* . . . . .	1

\* Unassociated with original disease.

39

tion, regardless of the paucity or absence of signs of suppuration and regardless of an assumed or actual distant complication.

Tables III, IV, V and VI are presented because they are large groups of cases and not because the causes of death were found to be different from those in other groups. The operations performed comprised the very varied list of procedures that would be found in any large series. In the group of exploratory laparotomies, operations for the most part for irremediable lesions, were placed only those procedures consisting in opening the abdomen, exploration, and the removal of specimens in some instances. The relatively unimportant differences in the causes of death between the different groups will be noted. Many individuals well past middle age are included in the



# NEUHOF AND AUFSES

TABLE IV

## 76 Operations on the Genito-urinary System

Causes of death	55 Non-suppurative cases		21 Suppurative cases	
	Number of cases	Per cent	Number of cases	Per cent
1. Original disease.....	5	9	20	95
2. Suppuration.....	24	44	0	
3. Suppuration plus systemic disease.....	0		0	
4. Suppuration plus pneumonia.....	4	7	0	5
5. Pneumonia.....	10	18	0	
6. Pneumonia plus systemic disease.....	1	2	0	
7. Miscellaneous.....	11 <sup>a</sup>	20	1 <sup>b</sup>	
	55		21	

<sup>a</sup> *Miscellaneous causes:*

Embolism and thrombosis.....	4
Cardiac disease and arteriosclerosis.....	4
Pulmonary tuberculosis.....	2
Renal disease.....	1
	11

<sup>b</sup> *Miscellaneous causes:*

Ileus (non-peritonitic).....	1
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TABLE V

## 91 Operations on the Liver, Gall Bladder and Ducts

Causes of death	64 Non-suppurative cases		27 Suppurative cases	
	Number of cases	Per cent	Number of cases	Per cent
1. Original disease.....	10	16	20	74
2. Suppuration.....	23	36	0	
3. Suppuration plus systemic disease.....	0		0	
4. Suppuration plus pneumonia.....	3	5	2	7
5. Pneumonia.....	5	8	1	4
6. Pneumonia plus systemic disease.....	2	3	0	15
7. Miscellaneous.....	21 <sup>a</sup>	32	4 <sup>b</sup>	
	64		27	

<sup>a</sup> *Miscellaneous causes:*

Hæmorrhage.....	6
Cardiac disease and arteriosclerosis.....	5
Ileus (non-peritonitic).....	4
Acute yellow atrophy of the liver.....	2
Renal disease.....	1
Duodenal fistula.....	1
Acute pancreatitis*.....	1
Embolism and thrombosis.....	1
	21

<sup>b</sup> *Miscellaneous causes:*

Cardiac disease and arteriosclerosis.....	3
Duodenal fistula.....	1
	4

\* Unassociated with original disease.

## CAUSES OF DEATH AFTER OPERATION

TABLE VI

54 *Exploratory Laparotomies*

Causes of death	47 Non-suppurative cases		7 Suppurative cases	
	Number of cases	Per cent	Number of cases	Per cent
1. Original disease.....	26	55	6	86
2. Suppuration.....	10	21	0	
3. Suppuration plus systemic disease....	0		0	
4. Suppuration plus pneumonia.....	0		1	14
5. Pneumonia.....	2	5	0	
6. Pneumonia plus systemic disease.....	3	6	0	
7. Miscellaneous.....	6 <sup>a</sup>	13	0	
	47		7	

<sup>a</sup> *Miscellaneous causes:*

Cardiac disease and arteriosclerosis.....	2
Hæmorrhage.....	3
Embolism and thrombosis.....	1
	6

genito-urinary group and the proportionately higher mortality from pneumonia and miscellaneous causes (cardiovascular disease) is probably ascribable to the age factor. Some allowances should be made for a margin of error in the placing of cases in the correct columns in the three groups. For example suppuration in the biliary tract might exist and not be noted at operation for a recently subsided acute cholecystitis, or renal infection may already be present at the time a prostatectomy is performed. It should be stated, however, that, as far as could be learned from the clinical data, cases were placed in their proper categories and that they were placed in the group of suppurative cases whenever there was serious doubt about classification.

Pneumonia is so often in the foreground as a post-operative complication that a special study of its diagnosis, occurrence and significance was made in 500 consecutive cases that came to autopsy. A case was classified as one of pneumonia only when the chart stated "pneumonia" to be the diagnosis. Arbitrarily only those were included in which the diagnosis of pneumonia was made within a week of death, for there might have been difficulties in the post-mortem check-up when the diagnosis had been made at earlier periods. The average time from diagnosis to death was three days. Pneumonia was diagnosed in eighty-four cases and was found at autopsy in fifty-one cases, or 60 per cent. The following significant pathological processes were found in the thirty-three cases in which pneumonia had been erroneously diagnosed:

Pulmonary embolism.....	2 cases
Pulmonary atelectasis.....	6 cases
Septicemia.....	5 cases
Hemoperitoneum.....	1 cases
Empyema secondary to subphrenic abscess.....	2 cases
Intraperitoneal abscess.....	2 cases
Diffuse suppurative peritonitis.....	15 cases

No reference will be made to the variety of pathological processes found in the lungs at autopsy to which there were no corresponding references on the clinical charts, for clinical observations may have been made and not recorded, or patients may have been too ill to be subjected to adequate examination of the chest. It is evident, however, that the diagnosis of post-operative pneumonia in sick patients is fraught with difficulty and that classical physical signs of pneumonia do not prove its presence in serious post-operative conditions. The important aspect of the matter lies in the likelihood of committing a grave error by ascribing to pneumonia a serious clinical condition that may be due to suppuration in the field of the operation.

The statement made at the outset, that this investigation was in no way related to a study of operative mortality, will be recalled. We were only concerned with the question of why patients die after operation, not with mortality of various operative procedures. The causes of death in a large series of autopsied cases derived from three representative hospitals have been presented. There is every reason to assume that similar results would be obtained from an analysis carried out at other institutions, for the figures of the three series corresponded closely. Suppuration is the outstanding primary cause of death after operation. The great variety of forms of suppuration noted at autopsy need not be enumerated. There were many instances of single localized collections of pus, accessible to drainage, to which the primary cause of death could be ascribed. What would or might have happened after drainage of such abscesses cannot of course be stated. It is, however, fair to assume that better chances for recovery would have existed.

In our opinion, suppuration following operation for non-suppurative disease is in no way related to errors in technic. On the contrary the highly finished operative technic of today may be the indirect cause. Surgical technic has advanced to such a degree that various formidable operative procedures infrequently practised some years ago are daily occurrences at the present time. Indeed, is it not true that so much reliance is now placed on facile technic that the thought of the patient's margin of safety has to some degree receded into the background? Why will the identical finished technic, applied to an excision of the intestine for example, succeed in one case and be followed by leakage through the suture line and peritonitis in the next? We believe that the answer is to be found in the series of simple exploratory laparotomies, a large proportion of the patients dying of intraperitoneal suppuration. Not only do poorly nourished tissues invite infection; infection is invited in all poorly nourished patients. However, the records also show that suppuration may supervene and be the cause of death after technically satisfactory major operations on patients deemed good surgical risks according to present standards.

## POST-OPERATIVE SHOCK AND SHOCK-LIKE CONDITIONS TREATMENT BY INFUSION IN LARGE VOLUME \*

BY WILLIAM F. MACFEE, M.D., AND ROBERT R. BALDRIDGE, M.D.  
OF NEW YORK, N. Y.

A NUMBER of theories have been advanced to explain shock. One of the most popular of these has been the neurogenic theory which ascribes the fall of blood pressure and consequent shock to exhaustion of the vaso-motor centre. Mitchell, Morehouse, and Keen<sup>1</sup> suggested this possibility near the close of our Civil war. Crile<sup>2</sup> has been its chief sponsor in more recent years.

During the World war, a Research Committee was appointed by the British Government to study traumatic shock. Largely through the activities of this committee, important observations and discoveries bearing upon shock were made. Dale and Laidlaw<sup>3</sup> were able to produce typical shock in animals by the intravenous injection of histamine, and thereby to study shock under experimental conditions. Upon opening animals, moribund from this type of shock, they found the heart executing muscular beats of moderate vigor, although the arteries were pulseless. The veins were not distended, and if clamped, they filled very slowly from the periphery. A large part of the blood, in fact, had disappeared from active circulation. It appeared that the weakness of the heart beat was due to a reduced inflow from the veins and not to any essential cardiac deficiency.

In the shock of wounded soldiers Robertson and Bock<sup>4</sup> and Keith<sup>5</sup> have demonstrated a diminution in blood volume, even in the absence of significant hæmorrhage. In experimental shock Gasser, Erlanger and Meek<sup>6</sup> have made similar observations.

The investigations of Cannon, Fraser and Hooper,<sup>7</sup> Taylor,<sup>8</sup> and Robertson and Bock<sup>9</sup> showed that a concentration of corpuscles existed in the capillaries as compared with the veins. Since the ratio of corpuscles to plasma in the veins remained approximately normal, it was assumed that there was a loss of plasma from the capillary channels. These observations have been amply confirmed, both in clinical and in experimental shock.

A large part of the blood which is out of active circulation is to be found, concentrated and stagnant, in the capillaries. Here additional loss of volume occurs by continuous passage of plasma through the capillary walls. Such diminution of volume of actively circulating blood has been called oligæmia, or exæmia, and is now believed to be a very important factor in the production and aggravation of shock.

The inevitable result of oligæmia is impaired effectiveness of circulation and diminution of oxygen supply to the tissues. Because of inadequate

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\* Read before the Surgical Section of the New York Academy of Medicine, October 4, 1929.

oxygen supply. it is probable that changes in osmotic pressure conditions, and other physico-chemical changes not well understood, occur in the capillary areas. That these result in a further loss of circulating fluid is suggested by Hill and McQueen,<sup>10</sup> whose explanation of the sequence of events in shock we find attractive: "With a falling blood pressure as in shock, there is a general constriction of arterioles to maintain sufficient pressure to supply the heart and brain. The general capillary field is sacrificed to the arterial pressure in the brain and heart. A sure Nemesis awaits this method of restoring blood pressure if carried too far. De-oxygenation sets in in the capillary area, the osmotic pressure of the tissue cells rises and these imbibe more fluid, the viscosity of the concentrated blood increases, the capillary wall may suffer and become increasingly permeable. The kinetic pressure available in the capillary area, already a small fraction of a few millimetres of mercury, is inadequate to maintain the blood flow and the heart, so carefully shielded from oxygen want by vaso-constriction elsewhere, finds itself with progressively less and less blood to propel." This chain of events leads to a further decrease in blood pressure and a continuation of the vicious cycle with ultimate complete failure of circulation.

Hill,<sup>11</sup> Krogh,<sup>12</sup> Hooker<sup>13</sup> and Rich<sup>14</sup> have demonstrated that there are numerous capillary channels which under ordinary conditions do not function, but which dilate to receive blood when local tissue needs demand it. The dilation of these capillaries in answer to oxygen want in the tissues probably constitutes an important factor in the loss of blood from the main circulating channels.

Another factor in the production of oligæmia which we believe should be stressed is dehydration. Maintenance of proper blood volume depends to a great extent upon a sufficient reserve of fluid in the tissues or tissue spaces. If a deficiency of circulating blood is threatened it is obvious that the tissue fluids cannot be drawn upon unless they exist in adequate amounts. It is well known that patients who have lost much fluid, as from prolonged vomiting or diarrhœa, are more likely to fall into shock than are patients whose fluid balance has been maintained. Direct loss of circulating fluid through hæmorrhage has long been recognized as an important factor in the production of shock. In the presence of dehydration the loss of a small amount of blood may assume an importance out of all proportion to the amount of blood lost.

A great deal may be done to prevent shock. Diligence in this direction is better than the most skillful treatment after shock is established. An ample supply of fluid should be insured before, after, and sometimes during operation. It is easier to maintain fluid balance than to restore it. Occasionally, however, one is confronted unexpectedly by shock. It may arise under circumstances which are out of control, or it may occur after the most careful preparation and operative procedure.

A plan of treatment for shock has been outlined recently by Cowell.<sup>15</sup> He recommends the following measures: 1, Application of warmth; 2, Pro-

cure mental rest ; 3, Relief of pain ; 4, Restoration of deficient circulation by giving fluids by mouth, rectally, or by 10 per cent. glucose-saline solution intravenously (one litre in two hours) ; 5, Increase of intra-cellular oxygenation by insulin hypodermically (five units at beginning and at end of infusion) ; 6, If operation is needed, by choosing a local or gas-oxygen anæsthesia. Similar suggestions have been made by Fraser<sup>16</sup> in a post-war publication.

In civil practice, cold does not generally play so great a part as in war injuries, but maintenance of warmth is not to be overlooked. Procuring mental rest and relief of pain are important as early measures. In well-established shock, mental unrest and pain usually are strikingly absent. There is instead a remarkable apathy, and sensibility to pain is blunted. Often a needle may be thrust into the vein, or the vein may be cut down upon with little or no disturbance to the patient.

It is chiefly with restoration of deficient circulation that we are concerned. Cardiac stimulants, in the absence of organic cardiac disease, are generally uncalled for. Likewise the use of adrenalin to raise blood pressure is to be condemned. Acting as it does upon the arterioles, its effect is to raise the blood pressure in the arterial tree. But, as pointed out by Cannon,<sup>17</sup> this does not improve volume flow in the capillaries. “. . . Merely a higher arterial pressure is not the desideratum in the treatment of shock, but a higher pressure which provides an increased nutritive flow through the capillaries all over the body. This can be obtained . . . only by increase of the volume flow.” Bainbridge and Trevan,<sup>18</sup> injecting adrenalin slowly into the veins of anæsthetized dogs for twenty minutes or longer, at a rate sufficient to raise and maintain blood pressure moderately high, found upon stopping the injection that the animals' blood pressure fell to a low level, with the development of typical shock.

To restore effective circulation it is necessary to restore and maintain the volume of circulating fluid. The importance of an abundant supply of water has been emphasized. Administration by mouth is often impossible or inadequate. The same may be said of rectal instillations. Fluid given subcutaneously, even in large amounts, is likely to be ineffective if shock is at all profound. It is absorbed so slowly that elimination keeps pace with absorption, and the blood volume is not increased. Intravenous injection is the only method by which volume of circulating fluid may be augmented quickly and surely.

For this purpose a number of fluids have been used. Whole blood has many advantages, especially if there has been hæmorrhage. It supplies erythrocytes as well as volume. Furthermore, it does not readily escape from the vessels. Its greatest disadvantages are the lack of ready and adequate supply, and the technical procedures involved in its administration.

The substitutes for blood most frequently employed are solutions of sodium chloride, glucose, acacia, and their combinations. It has long been known that normal salt solution may be safely used for intravenous administration. Clinical experience with it in the treatment of shock has heretofore

been disappointing. Fraser and Cowell,<sup>19</sup> treating shock from war wounds, gave as much as two pints of normal saline solution intravenously to a number of patients. They obtained a temporary rise of blood pressure which was followed by a rapid fall to a level sometimes below the original. Drummond and Taylor<sup>20</sup> record similar conclusions as to the value of salt solutions. Cannon<sup>21</sup> and Bayliss<sup>22</sup> ascribe this failure to the prompt passage of the solution from the capillaries into the tissue spaces. Hypertonic salt solutions proved no better than the normal solution.

Hypertonic glucose solutions have been employed with the idea of increasing blood volume, both directly and by extraction of tissue fluids, and at the same time supplying carbohydrate. It was hoped that glucose might be the means of combating the acidosis of shock. Cannon<sup>23</sup> found, however, that the blood sugar in shock is above normal, and that it is not related to the decreased alkali reserve. Acetone bodies were absent from the urine. The acidosis of shock is not the same as that of diabetes. Thalhimer,<sup>24</sup> Fisher,<sup>25</sup> Beresow,<sup>26</sup> and others, have reported good results by combining the use of insulin with glucose, Padgett and Orr,<sup>27</sup> however, treating experimental shock with glucose solutions, obtained almost identical results whether given with or without insulin. It seems probable that the beneficial effects of glucose are due largely to the water introduced with it.

The principal fault found with the simple crystalloid solutions is that they have generally failed to maintain blood pressure. A primary elevation has been obtained, but has been quickly lost as the solution escaped from circulation.

To overcome this difficulty Bayliss<sup>28</sup> introduced the use of gum arabic. A solution of 0.9 per cent. sodium chloride, containing 6 to 7 per cent. gum arabic has the viscosity of blood and the osmotic pressure of its colloids. It is chemically inert and apparently harmless. It will not pass through the capillary walls and retards the passage of water. Good results from its use have been reported by Drummond and Taylor,<sup>29</sup> who are quoted by Bayliss. Farrar<sup>30</sup> and Randall<sup>31</sup> likewise have found it useful in the field of gynecology and obstetrics. On the other hand, there have been unfavorable reports. Lee<sup>32</sup> mentions two patients in whom he thinks death was hastened by acacia. Hanzlik and Karsner<sup>33</sup> report anaphylactoid phenomena in animals injected with solutions of acacia in saline. Whatever its eventual status in the treatment of shock may be, acacia has not yet come into very extensive use. In addition to the fear of it, whether justified or not, there is the difficulty, in general hospital practice, of securing reliable preparations.

To specifically combat the exæmia of shock we may inject into the vein a fluid, such as blood itself, or the gum-salt solution of Bayliss, with the idea of having it remain in the blood vessels. With the increase of blood volume, blood pressure will be raised, oxygenation of the tissues will be increased, and the vital condition of all the cells in the body will be improved. If a sufficient amount of water can be given afterward, one may expect a lowering of osmotic pressure in the tissues, and the establishment of a balance with

the blood stream. Unfortunately, there are disadvantages which limit the use of these two substances.

Instead of using a fluid which is expected to remain in the blood vessels, we may select a solution such as normal salt or glucose. These, as we know, readily escape from the blood vessels, and are taken up by the fixed tissues, or stored in the tissue spaces. This probably occurs, at least partly, in answer to the physiological demands of the tissues. If solutions of sodium chloride or glucose are to be effective in the treatment of fully developed shock, they should be given in large quantity. In the first place, fluid requirements of the tissues must be met. In the second place, stagnant erythrocytes must be mobilized, viscosity of the blood reduced and blood volume increased. To do this we must fill a circulatory system which, owing to capillary dilation and an increase in number of open capillaries (Krogh<sup>34</sup>), is more capacious than under normal conditions.

We believe that the previous failures with salt solutions have been due to the administration of insufficient quantities. By injecting large amounts of fluid we have had gratifying results in a number of cases treated at St. Luke's Hospital during recent months. In nearly all the cases we have used normal salt solution, often with the addition of varying amounts of glucose. The solution has been given intravenously in amounts ranging from 2000 cubic centimetres to 8000 cubic centimetres at a single injection. The usual amount required has been about 4500 cubic centimetres. It has been given at the rate of about 500 cubic centimetres in ten to twenty minutes. Altogether forty infusions of saline and glucose have been given to thirty patients. Six patients have received a transfusion of blood (500 cubic centimetres) in addition to infusion. As far as we have been able to judge, all the cases treated by infusion were benefited to some extent. In several cases the treatment seemed to be a life-saving measure. In other cases, who eventually died, we have felt that death was due, not primarily to shock, but to the morbid condition which had produced shock.

The post-operative shock-like conditions observed resulted from a considerable variety of diseases. The signs leading to the diagnosis of shock, however, were much the same. The measurable indications of shock following radical mastectomy, for example, differed little from those observed in the "toxæmia" of intestinal obstruction, or of general peritonitis. Delbet<sup>35</sup> and Olivecrona<sup>36</sup> have already called attention to the similarity between traumatic shock and the shock-like condition associated with peritonitis. Similarity in response to treatment has likewise been striking and suggests that a variety of causes may lead essentially to the same condition. Whether it is called "toxæmia" or shock makes little difference so far as the treatment is concerned.

The infusion treatment, in common with other kinds of shock treatment, is most effective when administered early, and when the initiating cause or disease has been removed. Its best results are seen when shock is due simply to a severe operation, uncomplicated by infection, or other factors



not easily eliminated. It is less likely to be permanently beneficial when shock has been produced by a continuing cause, such as peritonitis, or other severe infection. In cases of this type the patient may be brought out of the shock-like state. Then, if his powers of resistance to the disease are good, he probably will go on to recovery. If, however, the infection is overwhelming, shock may again supervene. Infusion can be repeated. The ultimate outcome may be either recovery or death. The infusion treatment in such cases has been useful in so far as it has permitted the patient to combat the disease without the added complication of shock. Infusion, of course, has no specific effect on the underlying disease.

Changes in blood chemistry immediately following infusion have not been striking. Such later changes as have occurred are explainable upon the basis of improved circulation and increased elimination.

The clinical improvement observed in some cases has been impressive. Some of the most interesting changes noted have been the return of normal color to ashen features, often as striking as if a transfusion of blood had been given; a return of tone to the facial muscles, notably those of the eyelids and mouth; a return from lethargy, or even unconsciousness, to relative mental alertness; a slowing of the pulse, with improved quality; the rapid increase of blood pressure, with stabilization near the normal pressure; return of renal function, with disappearance of "urinary suppression"; and, in general, the transition from a precarious condition to one of relative safety.

If given under careful supervision, we believe the administration of the large amounts suggested is safe. In no case have there occurred alarming signs or symptoms of cardiac or respiratory embarrassment. Three patients became a little restless and apprehensive and appeared slightly dyspnoic. In these cases the rate of flow was reduced and symptoms abated. Two patients developed severe chills during infusion. In both of these unbuffered stock solutions of 5 per cent. glucose were being used. The onset of chill occurred in one case after the administration of 1500 cubic centimetres. The infusion was immediately discontinued and no harm resulted. In the second case the chill did not appear until after 3500 cubic centimetres of glucose solution had been given. In this case the glucose was stopped but infusion was continued with normal saline. During the administration of saline solution the chill disappeared. In general, we have had more favorable results when saline was used either alone, or with the addition of prepared ampules of glucose solution. When glucose has been given with the salt solution, we have usually added 50 cubic centimetres of a 50 per cent. solution to 1000 cubic centimetres of normal saline. We have observed little difference whether the saline is given with or without glucose.

We are not unmindful that frequent warnings have been issued stressing the dangers attending intravenous injections of fluids, particularly if given in large amounts. Fatalities following infusion have been recorded in the literature. Acute cardiac dilatation has been cited as a frequent cause of

death. While we have encountered nothing of this kind, we nevertheless would urge constant vigilance. It has been our policy to have the patient under the immediate observation of one of the house staff during the entire infusion. The pulse has been watched at all times, and the blood pressure recorded after the administration of each 500 cubic centimetres of fluid.

Of thirty treated patients, eight died. The causes of deaths were as follows: general peritonitis (three cases), gangrenous ileo-colitis (one case), carcinoma of kidney (one case), intestinal obstruction (one case), liver abscess, tertiary lues, and diabetes mellitus (one case); and carcinoma of breast, bilateral (one case). Death occurred from seven to seventy-two hours after infusion, and from fourteen hours to eight days after operation. Five autopsies were done. In none was there evidence of cardiac dilatation. Two cases, both women, who were moribund when the infusion was begun, showed some pulmonary oedema. The two lungs in one case weighed at autopsy 1200 grams. The lungs of the other case weighed 1310 grams. The average weight for the lungs of a female is given by Morris<sup>37</sup> as 1023 grams.

In the field of animal experimentation there is abundant evidence that any excess of sodium chloride or glucose solution is quickly eliminated from the blood stream. Smith and Mendel,<sup>38</sup> working with rabbits, made intravenous injections of various isotonic solutions in amounts equivalent to the estimated blood volume of the animal. The solutions were injected in two minutes' time. Repeated blood volume determinations were made afterward. In the case of 0.9 per cent. sodium chloride solution, it was found that the larger part of the solution disappeared within the first five minutes after injection, and in the majority of cases, blood volume returned to normal within half an hour.

Lamson and his associates<sup>39</sup> obtained similar results with dogs. Gasser and Erlanger,<sup>40</sup> Smith,<sup>41</sup> and others, have obtained parallel results with glucose solutions.

To establish the relative merits of glucose and sodium chloride solutions in the treatment of shock, further work is needed. Cases of our own who have had blood sugar determinations done before treatment have shown normal, or above normal, content. As a rule plasma chlorides likewise have been normal. It is likely that the greatest value of both glucose and sodium chloride is as an adjunct to the safe administration and retention of water.

The following cases are recorded to illustrate the effects of treatment:

#### ILLUSTRATIVE CASES

I. CASE NO. 70388.—E. B., white, female, forty-two years. *Operation.*—February 9, 1929, for congenital anomaly of pancreas, producing obstruction of the common bile duct and chronic pancreatitis.

*Post-Operative Course.*—February 10, 1929, 11 A.M. Face very pale, yellowish color; eyes sunken, half closed; lips and tongue dry; fibrillary twitchings of muscles; completely unconscious; death seems imminent. *Infusion.*—4300 cubic centimetres normal saline solution with 100 grams glucose, and ten units insulin.

# MACFEE AND BALDRIDGE

Time	Fluid	Temp.	Pulse	Resp.	Remarks
11:30 A.M.	0	106.6	Too rapid and feeble to count	5 (irreg., gasping)	Apparently moribund
12 NOON	1000		180	9 (irreg.)	Color better
12:30 P.M.	2000		168	9 (irreg.)	Color good
1:00	2800	106.3	156	11	Voided 100 c.c. (acetone-o)
1:45	3200	105	150	13	Twitchings have ceased; conscious; thirsty
2:45	4100		136	12	Vomited
3:15	4300	104	126	12	Comfortable; absolutely conscious
Infusion discontinued.					
9:00 P.M.		101.3	120 (strong)	16	Retaining fluids by mouth

*Note.*—Blood pressure readings were, unfortunately, not recorded.

*Result.*—Uneventful recovery.

II. CASE No. 69571.—White, male, twenty-six years. Adm. B. P. 120/80. *Operation.*—February 27, 1929. Trans-duodenal excision of common duct stone.

*Post-Operative Course.*—February 28, 1929. Transfusion of blood, 600 cubic centimetres. Developed duodenal fistula, second post-operative day, profuse leakage. *Infusion.*—March 8, 1929. Pale, jaundiced gray color; skin, lips and tongue dry; eyes moderately sunken; thirsty; prostrated; mentally depressed and talks about dying. *Infusion.*—4500 cubic centimetres of normal sodium chloride solution.

Time	Fluid	Temp.	Pulse	Resp.	B. P.	Remarks
1:30	0	99	120	20	98/86	See above
1:45	500		108	20	110/80	
2:00	1000	98.4	108	20	118/80	
2:15	1500		108	14	125/80	Asks for water
2:30	2000		106	14	132/80	More alert, asks ques- tions about treatment
2:45	2500		105	12	142/85	
3:00	3000		105	14	140/80	
3:15	3500		106	13	145/80	Voided 576 cubic centi- metres
4:00	4000		106	13	148/80	
4:20	4500		106	13	150/82	
Infusion discontinued.						

# INFUSION TREATMENT OF POST-OPERATIVE SHOCK

Time	Fluid	Pulse	Resp.	B. P.	Remarks		
6:00		103	16	134/80			
10:00		92	18	132/78			
March 9, 1929		82	16	134/80	Duodenal tube passed beyond fistula for feeding		
March 10, 1929		90	18	130/80			
		Urea N	CO <sub>2</sub>	Chlor.	Sug.	Bile Ind.	
<i>Note</i> —Adm. B. P.—120/80							
Bl. Chem. 3/8/29 before infusion		71.5	57.6	4.5		15	
Bl. Chem. 3/9/29 20 hrs. after		50.0	61.7	5.25	125	13	

*Result*.—Alarming symptoms disappeared after infusion. A second infusion of small amount was given a few days later. Patient made a good recovery.

III. CASE No. 72760.—White, female, thirty years. *Operation*.—March 19, 1929. Laparotomy and drainage for general peritonitis, streptococcus hæmolyticus, of undetermined origin.

*Post-Operative Course*.—March 21, 1929. Face generally pale with slight flushing of cheeks; eyes sunken with bluish discoloration about them; lips dry; skin moist; abdomen much distended; constant vomiting of brownish, foul-smelling material; anxious, but mentally clear; critically ill. *Infusion*.—5000 cubic centimetres normal saline.

Time	Fluid	Temp.	Pulse	Resp.	B. P.	Remarks	
9:20 P.M.	0	104.8	122	23	133/80	Restless, complains of thirst	
9:44	1000		106	26	140/74	Alternately dozing and awake. Asks for water	
10:27	3000		114	36	144/74		
11:15	5000	105.4	116	40	148/76	Again restless, anxious to be left alone, dyspnoëic	
Infusion discontinued.			(Good)				

	R. B. C.	Hgb.	W. B. C.	P.	L.
Bl. Ct. before inf.....	4,600,000	90	28,800	90	10
Bl. Ct. after inf.....	3,400,000	92	12,800	88	12
Bl. Ct. 10 hrs. after inf.....	4,000,000	90	10,800	88	12

*Progress*.—March 22, 1929. Condition worse. Gastric lavage at 6 P.M. yielded foul fluid. Passing some gas by rectum. Two watery stools. Distention still very great.

*Second Infusion*.—March 22, 1929. 3500 cubic centimetres 5 per cent. glucose (unbuffered), plus 600 cubic centimetres normal saline.

Time	Fluid	Temp.	Pulse	Resp.	B. P.	Remarks	
7:30 P.M.	0	103.0	96 (weak)	24	110/64	Voided 700 cubic centimetres during infusion. Had chill toward end	
9:00	4100	104.8	136 (good)	40	165/80		

Infusion ended.

	R. B. C.	Hgb.	W. B. C.	P.	L.	Bl. U. N.	CO <sub>2</sub>	Sug.	Chlor.
Before inf.....	4,800,000	92	11,000	90	10	35.7	37.2	167	5.85
Immed. after.....	4,200,000	90	6,000	84	16				
12 hrs. after.....						29.4	39	125	6.

*Result*.—Gradual improvement after second infusion to complete recovery.

IV. CASE No. 71898.—White, female, forty years. Adm. B. P. 126/82. *Operation*.—April 2, 1929. Supra-vaginal hysterectomy for fibromyoma.

*Post-Operative Course*.—April 3, 1929. Developed symptoms and signs of peritonitis.

*Infusion*.—April 4, 1929. Definite severe general peritonitis, streptococcus hæmolyticus. Infusion of 5000 cubic centimetres normal saline solution.

Time	Fluid	Temp.	Pulse	Resp.	B. P.	Remarks
2:55 P.M.	0	104.2	126	30	98/72	Face pale and moist. Tongue and lips parched. Distended; apathetic
3:30	2500		120	27	120/65	
4:05	5000	102.4	120	32	135/70	Face flushed; pulse well sustained. Voided 250 cubic centimetres
Infusion discontinued.						
8:00		102	103	26	128/80	
	R. B. C.	Hgb.	W. B. C.	P.	L.	B. U. N. CO <sub>2</sub> Sug. Chlor.
Immed. before inf.	5,800,000	102	28,600	92	8	18.5 40.9 133 6.25
Immed. after inf.	4,000,000	84	28,800	90	10	12.5 39 118 6.5

*Second Infusion*.—April 7, 1929. 2000 cubic centimetres saline plus 1000 cubic centimetres 5 per cent. glucose.

Time	Fluid	Temp.	Pulse	Resp.	B. P.	Remarks
5:55 P.M.	0	104.4	160	44	94/66	Face pale. Breathing shallow. Mouth open
6:40	3000	103.4	146	51	116/62	Face flushed
Infusion discontinued.						
April 8, 1929		103	142	44	106/70	Some gas expelled

*Third Infusion*.—April 9, 1929. 4500 cubic centimetres saline with 50 grams glucose and 5 cubic centimetres digitan.

9:00 A.M.	0	106.4	150	40	70/?	Semi-conscious, condition grave
12:00 NOON	4500	102	130	45	114/66	Fully conscious, much improved
Infusion discontinued.						
8:00 P.M.		101.6	112		112/70	

*Fourth Infusion*.—April 10, 1929. 5,500 cubic centimetres saline with 50 grams glucose.

9:50 A.M.	0	104.8	135	18	64?/50?	In coma, face white. Eyes fixed; apparently dying
12:15 P.M.	5500		134	20	80/50	
Infusion discontinued.						
6:00						Unconscious. Shows some cedema of legs

*Result*.—April 11, 1929. Died.

*Autopsy*.—80 cubic centimetres fluid in right pleural cavity; 60 cubic centimetres fluid in left. Both lungs show moderate cedema and advanced congestion in both inferior lobes. Right lung weighs 710 grams. Left lung weighs 600 grams. *Heart* is normal. *Abdomen*.—Acute fibrinous peritonitis.

V. CASE No. 71944.—White, male, thirty-six years. *Operation*.—April 6, 1929. Gastro-enterostomy for duodenal ulcer. Cholecystectomy for chronic cholecystitis.

*Post-Operative Course*.—April 7, 1929. Twenty-four hours after operation, patient appeared quite ill; frequent vomiting; profuse sweating; face pale, lead gray color; eyes sunken; extremely prostrated; very apathetic; response to questions is slow but accurate. *Infusion*.—April 7, 1929. 5000 cubic centimetres normal saline solution.

# INFUSION TREATMENT OF POST-OPERATIVE SHOCK

Time	Fluid	Temp.	Pulse	Resp.	B. P.	Remarks
12:40 P.M.	0	100.3	120 (thin)	18	110/85	Drowsy
12:55	1000		102	22	125/75	Color better. More alert
1:10	2000		99	21	130/75	
1:25	3000		98	24	135/70	
1:40	4000		100	24	140/75	Talkative
2:05	5000	100.3	96	21	140/75	Marked clinical improvement
Infusion discontinued.						
April 8, 1929 3 P.M.					128/75	
April 9, 1929 3 P.M.					128/75	

*Result.*—Recovery.

VI. CASE No. 75570.—White, female, thirty-four years. *History.*—Seven days after delivery of a full-term baby, patient developed symptoms of acute intestinal obstruction. *Operation.*—September 27, 1929. (Three days after onset of symptoms.) Laparotomy revealed obstruction of upper small intestine due to volvulus. Adhesions freed and obstruction relieved with minimum of trauma and very little loss of blood.

*Post-Operative Course.*—Two hours after operation patient presented the typical picture of shock. *Infusion.*—2000 cubic centimetres normal salt solution (two hours after operation).

Time	Fluid	Pulse	Resp.	B. P.	Remarks
3:30 P.M.	0	140 Weak	24	80/64	Unconscious; condition poor
3:40	500	124 Slight Imp.	24	92/64	Cold
3:50	1000	120 Fair	24	110/68	Warmer; conscious
4:00	1500	112 Good	24	110/64	Conversing
4:10	2000	110 Strong	24	108/66	Asks for water
Infusion discontinued.					
September 29, 1929		84		125/80	

*Note.*—Urinary output during night before operation was 45 cubic centimetres. Catheterization two hours after infusion yielded 290 cubic centimetres.

*Result.*—Patient made a good recovery.

VII. CASE No. 74384.—White, male, forty-seven years. *History.*—Patient entered hospital with uniformly enlarged thyroid; general symptoms of hyperthyroidism; heart enlarged; auricular fibrillation; basal metabolism, plus 96. After one month of medical treatment, basal metabolism dropped to plus 15, and patient was operated upon. *Operation.*—September 5, 1929. Subtotal thyroidectomy.

*Post-Operative Course.*—Twelve hours after operation patient was extremely prostrated; pale; lips and tongue dry; very dyspnoic, breathing with mouth open; thirsty but too dyspnoic to drink, except small sips. Pulse rapid and weak, but regular.

*Infusion.*—3600 cubic centimetres normal salt solution twelve hours after operation

Time	Fluid	Temp.	Pulse	Resp.	B. P.	Remarks
9:00 P.M.	0		156	40	90/50	Condition critical
10:30	3600		144	32	155/65	Face flushed; respiration easy

*Notz.*—Most striking features were return of excellent color to face, improvement in quality of pulse, and relief of dyspnoea. At end of infusion patient asked for water and drank a full glass without difficulty. Twenty-four hours after infusion the blood pressure was 150/65.

*Result.*—Recovery.

# SUMMARY

1. Whatever the absolute cause of shock may be, the essential fact of shock is de-oxygenation of the body tissues.

2. De-oxygenation occurs from impairment of circulation.

3. The impairment of circulation results from diminution of blood volume *in circulation*. This loss is due to stagnation of blood in the capillary areas, and to escape of plasma from the capillary channels. Hæmorrhage and dehydration are frequent factors.

4. To rationally combat shock, restoration of volume of blood in effective circulation is of first importance.

5. Physiological sodium chloride solution has heretofore been tried as a medium to replace lost volume and has been generally discarded.

6. By using physiological sodium chloride solution, with or without glucose, in amounts much larger than have usually been employed, we have consistently obtained gratifying results in the treatment of shock.

7. The danger of producing acute cardiac dilatation or pulmonary œdema has not been apparent in a relatively short series of cases.

8. We practise and urge, however, constant vigilance during the administration of large amounts of solution.

9. We believe that the results obtained to date with this method of treatment warrant continuation of its use.

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- <sup>7</sup> Cannon, Fraser and Hooper: Report of Shock Committee, English Medical Research Committee, December, 1917, No. 25, p. 73; see also Journ. Am. Med. Assoc., 1918, vol. lii, p. 527.

## INFUSION TREATMENT OF POST-OPERATIVE SHOCK

- <sup>8</sup> Taylor: See footnote 2, Report of Shock Committee No. 25, p. 76.
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- <sup>19</sup> Fraser and Cowell: *A Clinical Study of the Blood Pressure in Wound Conditions*, 1917, Mem. No. 2 of the Shock Committee, pp. 1-26.
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## BRONCHIAL INJURY AND REPAIR \*

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THE reparative processes of bronchi following an injury have been infrequently considered either clinically or experimentally. However, this problem has been encountered quite often with the advent of lung surgery. In performing lobectomies and pneumectomies much difficulty has been experienced in obtaining a satisfactory closure of the bronchial stump. Bettman<sup>1, 2</sup> (1924) found that in a successful closure of the stump, the healing process consisted of peribronchial tissue, without which it was practically impossible to close a primary bronchus permanently. Also that a pneumectomy could not be performed successfully because of the lack of enough tissue to cover the stump.

Robinson and Sauerbruch<sup>3</sup> (1909), quoted by Bettman, make the following statements: "Experimental removal of a single lobe of the lung in dogs is almost always successful. The reverse is true following the complete extirpation of the lung, a few animals dying from infection, but more dying on the sixth to eighth day due to opening of the bronchus with resultant pressure pneumothorax and mediastinal emphysema." Willy Meyer's<sup>4</sup> (1909) successful closure of the stump of one or more lobes did not show healing of the bronchus to be playing a part in the closure. It is to be noted that a generous stump was left in Lilienthal's technic for lobectomy, as was also the case in Joannides'<sup>6</sup> experiments.

Again, the slowness to heal of many of the larger bronchial fistulæ is perhaps somewhat related to the problem of bronchial repair. The experiences of Halstead and Thurston,<sup>7</sup> Eggers,<sup>8</sup> Graham,<sup>9, 10</sup> Keller,<sup>11</sup> and others lead one to believe this to be true. Too often, operative interference has only caused a prolongation of the existence of the fistula. The difficulty and danger in closing some fistulæ is so great that the advice, "Hands off," for a period of months or even years, has been given<sup>12</sup> with the hope that a spontaneous closure may result.

With these problems in mind the task was entered upon to study experimentally, how the air passages, mainly bronchi, reacted to a severe injury, and the stages of healing in the repair of the damage.

EXPERIMENTAL.—Dogs were used exclusively; the weights ranging from 12 to 15 kilograms. A preoperative dose of morphine grains  $\frac{1}{2}$  per kilogram and atropine grains  $\frac{1}{150}$  per kilogram was given one-half to one hour before operation. No other

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## REPAIR OF BRONCHIAL INJURIES

anæsthesia was employed. The site of election for cauterization was usually the medial secondary bronchus of one of the lower lobes, this location being easily accessible and the optimum for observation. Occasionally the bronchus of the accessory lobe (sub-cardiac) was used.

Two types of cauterizing agents were employed, *viz.*: actual thermal cautery, and silver nitrate. For thermal cautery, four or five coils of a small wire attached to a nine-volt battery with a rheostat in the circuit were used. The coils were hot but not red, so that the effect was coagulating and not searing. For the silver nitrate cautery the stick form of the chemical was used, the stick being secured at one end of a brass tube by means of adhesive tape (Fig. 1).

*Procedure.*—About one-half to one hour after the morphine had been given, the dog was found to be in a stuporous state. (If too much morphine is given the dog will be hyperirritable.) With the animal secured in a dorsal position and a mouth gag in place, a bronchoscope (fashioned after Jackson's type) was introduced and carried down to one of the primary bronchi, and the medial secondary bronchus of one of the lower lobes located. The thermal cautery was then introduced under direct vision into the bronchus for a distance of one to two centimetres (it fit fairly snugly) and allowed to remain for ten seconds. After removal of the cautery, a white eschar 75 centimetres in width, was seen encircling the bronchial lumen.

In the case of silver nitrate, the stick was introduced into the medial secondary bronchus of the lower lobe (in place of the thermal cautery) and allowed to remain for one minute. On removing the cautery a greenish-white area of corrosion of about 1 to 1.5 centimetres in width was found encircling the bronchial lumen.

In the first few experiments, the silver nitrate was applied to both lower lobes. The dogs were unable to endure this amount and usually died on the second or third day of an intense bilateral pneumonia. In most of the work silver nitrate was used on one side and thermal cautery on the other.

The dogs were caged immediately following the procedure and sacrificed by electrocution<sup>13</sup> at intervals of: thirty minutes, three hours, one day, one week, two weeks, three to four weeks, six weeks and eight weeks, at which time gross and microscopic studies were carried out. For microscopic study hæmatoxylin and eosin and elastic tissue stains were made. In two dogs the bronchus of the accessory lobe was selected as the site of cauterization. Thermal cautery was repeatedly applied for ten-second periods at intervals of one to three weeks. Changes were noted from time to time by means of bronchoscopic examination (see protocols).

In obtaining the following results, a high rate of mortality was at times encountered. This is evidenced by the fact that, out of seventy dogs receiving cauterization, thirty-three died and thirty-seven were sacrificed. Part of this high mortality was not due to cauterization alone but to a combination of cauterization and pre-existing pneumonia. Also, as stated above, the first six dogs receiving silver nitrate on both sides, died within twenty-four to forty-eight hours. The mortality rate was low where either type of cautery was used alone and applied at only one location.

Microscopic studies were made on fifty-two of the seventy dogs. Thus several specimens of each stage were obtained, thereby eliminating the danger of drawing biased conclusions.

Typical protocols are as follows:

*PROTOCOL I.—Thermal Cautery.*—August 24, 1928. Dog No. 895, weighing 12 kilograms, was given 3.0 grains of morphine and 0.08 grams of atropine one-half hour before operation. With the animal secured in a dorsal position and a mouth gag in place, the bronchoscope was introduced into the larynx and carried down into the right primary bronchus. The medial secondary bronchus of the right lower lobe was visualized. The thermal cautery was directed into this bronchus for a distance of 1 to 2 centimetres and allowed to remain for ten seconds. Following removal of the cautery, a white eschar was noted encircling the lumen of the air passage. The bronchoscope and

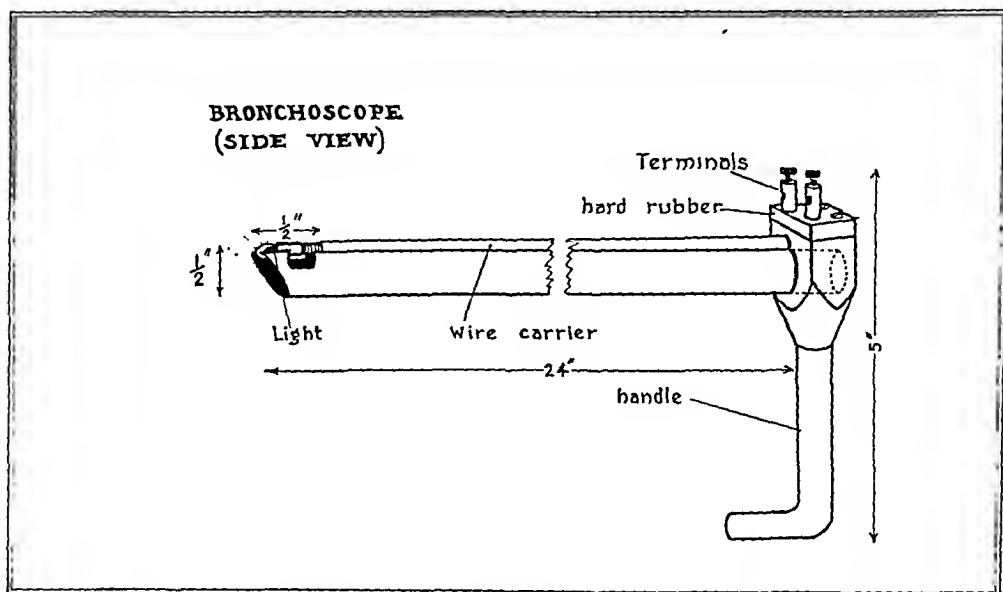


FIG. 1A.—Diagrammatic illustration of apparatus used in producing an injury to the bronchus.

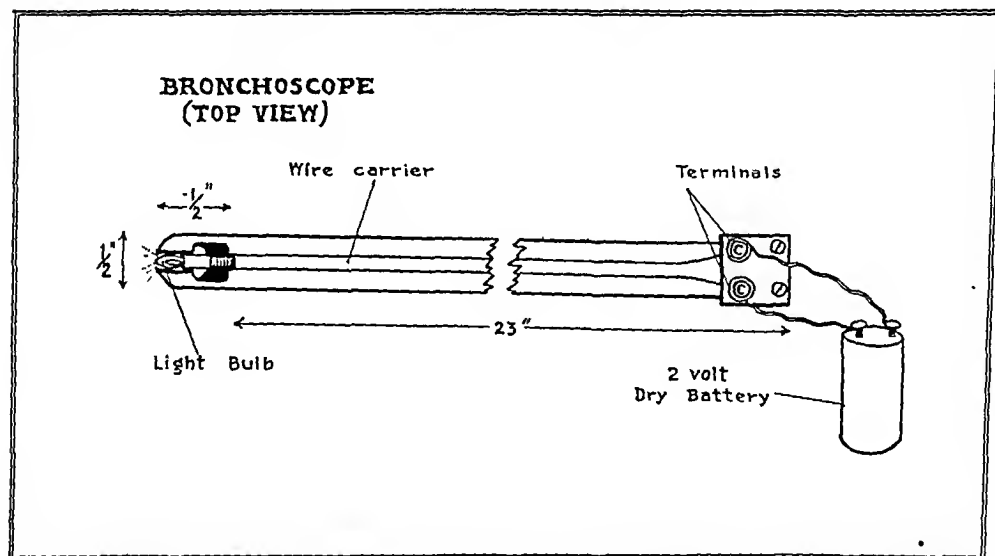


FIG. 1B.

# REPAIR OF BRONCHIAL INJURIES

## THERMAL CAUTERY

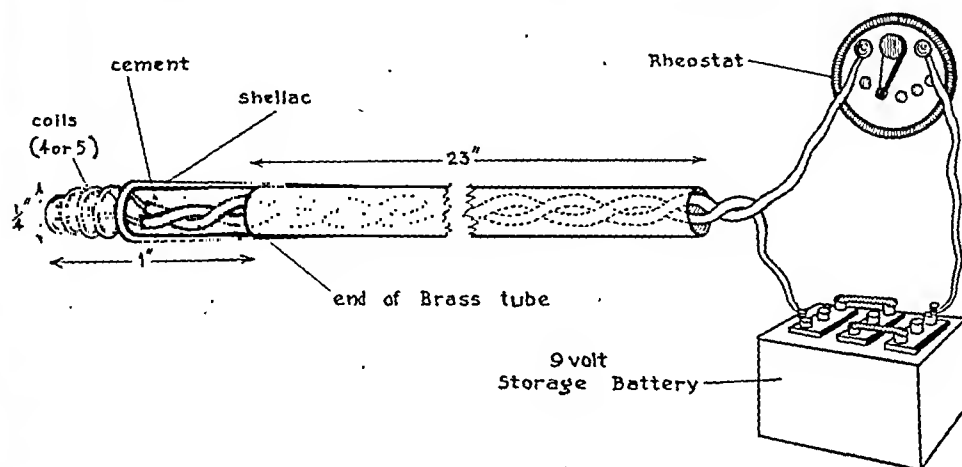


FIG. 1C.

## SILVER NITRATE CAUTERY

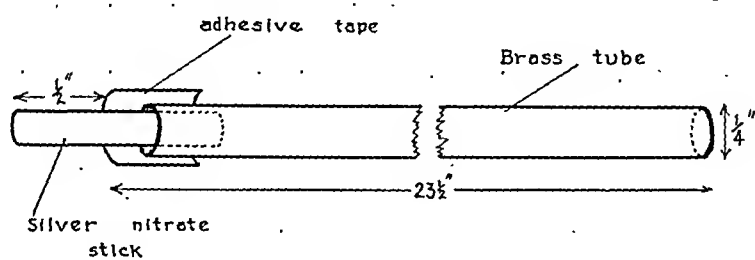


FIG. 1D.

mouth gag were removed, and the dog returned to his cage in a more or less stuporous state.

August 25, 1928, dog very quiet and listless. Did not eat. No coughing.

August 26, 1928, dog remained quiet and ate little. No coughing.

August 27, 1928, better today. Ate more although he continued to be quiet.

August 28, 1928, more active and ate well. No coughing.

August 29, 1928, appeared improved. Took food well. Occasional non-productive cough noted.

August 31, 1928, condition unchanged.

September 1, 1928, appeared practically normal although occasional non-productive cough was still present.

September 2, 1928, to November 24, 1928, animal appeared in good health.

November 24, 1928, sacrificed by electrocution.

PROTOCOL II.—*Silver Nitrate Caution*.—August 22, 1928. Dog No. 896, weighing 13.5 kilograms, was given 3.5 grains of morphine and 0.09 grains of atropine one-half hour before operation. The animal was secured lying on its back and a mouth gag inserted. The bronchoscope was introduced into the trachea and carried down to the right primary bronchus. The medial secondary bronchus of the right lower lobe was visualized and the silver nitrate stick directed into it for a distance of one inch. It was allowed to remain for one minute, during which time it was slowly rotated for a two-fold purpose, *viz.*: to cauterize the entire circumference of the wall, and to keep the silver nitrate stick from adhering to the bronchial wall and thus losing it on attempting withdrawal. After removal of the cautery the bronchial wall was found to be much corroded. The bronchoscope and mouth gag were removed and the dog returned to its cage, still in a stuporous state.

August 23, 1928, dog very quiet. Did not eat. No coughing or barking. Appeared quite ill.

August 24, 1928, little change noted.

August 25, 1928, occasional non-productive cough observed. Ate very little.

August 27, 1928, some improvement noted. Ate more and was more active. Cough still present.

August 28, 1928, took food quite well. Still coughing.

August 30, 1928, improved. Less cough noted.

September 1, 1928, quite well. Took food very well and only very occasional cough noted.

September 2, 1928, to November 22, 1928, animal appeared in good health.

November 22, 1928, sacrificed by electrocution.

PROTOCOL III.—*Repeated Thermal Caution*.—August 27, 1928. Dog No. 935, weighing 12 kilograms, was given three grains of morphine and 0.08 grains of atropine one-half hour before operation. The animal was secured in a dorsal position and a mouth gag inserted. The bronchoscope was introduced into the trachea and carried down into the right primary bronchus. The bronchial opening to the accessory lobe was visualized. The thermal cautery was introduced into it for a distance of 0.5 inches and allowed to remain for ten seconds. Following removal of the cautery, the entire circumference of the bronchial wall presented a white eschar about .75 centimetre in width. The bronchoscope and mouth gag were removed and the dog returned to its cage. Its behavior for the week following was no different than that of dog No. 895, described above.

September 4, 1928, X-rays showed no demonstrable pathological changes in the lungs. The dog was given 2.5 grains of morphine and bronchoscoped one-half hour later. The accessory lobe bronchus, at the site of injury, was found much reddened, swollen, oedematous and bleeding. Thermal cautery was applied for five seconds to the

## REPAIR OF BRONCHIAL INJURIES

site of original cauterization. The reaction of the dog during the following week was very similar to that following the first cauterization.

September 11, 1928, X-rays again showed no demonstrable pathological changes. Bronchoscopy (following morphine grains 2.5): The origin of the accessory lobe bronchus was found much swollen and œdematous with the size of its lumen diminished. No cautery was applied at this time.

September 12, to 19, 1928, dog appeared in good health; eating well and no coughing.

September 19, 1928. Bronchoscopy (following morphine grains 2.5): Much swelling and œdema of site cauterized. No cautery applied. Dog appeared normal during the week following.

September 27, 1928. Bronchoscopy (following morphine grains 2.5): The origin of the accessory lobe bronchus was found partially stenosed. It did not appear acutely inflamed. Thermal cautery was applied for ten seconds.

September 27, to October 4, 1928, dog was quiet for the first day following cauterization, then appeared normal again, eating well and not coughing.

October 4, 1928. Bronchoscopy (following morphine grains 2.5): The origin of the accessory lobe bronchus was filled with a muco-purulent discharge. Some reddening of the mucosa was present. No cautery applied. During the two months following the dog appeared normal and healthy.

December 6, 1928. Bronchoscopy (following morphine grains 2.5): The origin of the bronchus cauterized showed definite marked stenosis. Thermal cautery was applied for ten seconds. The dog was quiet for a day, then appeared quite normal for the three weeks following.

December 31, 1928. Bronchoscopy (following morphine grains 2.5): An increase in the degree of stenosis of the bronchus was noted. No inflammation was seen. Thermal cautery applied for ten seconds. The dog was quiet for a day, then appeared normal for the three weeks following.

January 22, 1929. Bronchoscopy (following morphine grains 2.5): The origin of the accessory lobe bronchus was found markedly stenosed. The lumen was about 2 millimetres in diameter. Thermal cautery was applied for ten seconds. The dog was quiet for a day, then appeared normal during the two weeks following.

February 6, 1929. Bronchoscopy (following morphine grains 2.5): The origin of the accessory lobe bronchus was completely stenosed. No cautery applied. Dog appeared normal for two weeks following.

February 20, 1929. Bronchoscopy (following morphine grains 2.5): The bronchial origin was completely stenosed as seen before. No cautery applied.

June 5, 1928, sacrificed by electrocution.

**RESULTS.—Thermal Cautery—Thirty-Minute Specimen.** *Gross Pathology.*—The surface of the lung lobe appeared normal. The bronchus presented a white eschar at the site of cauterization. Surrounding this was a zone of hyperæmia and œdema extending for a distance of 0.5 centimetre away from the bronchial wall.

*Microscopic Pathology.*—The bronchial wall was entirely necrosed, except for a small part of the cartilage. The surrounding parenchyma presented dilated vessels. Much œdema with but little hæmorrhage was present.

*Silver Nitrate Cautery—Thirty-Minute Specimen.* *Gross Pathology.*—A slight injection was noted on the surface of the lung lobe opposite the site of cauterization. The bronchial wall showed much corrosion at the site of cauterization around which much hyperæmia and œdema were seen extending for 2 centimetres away from the bronchial wall.

*Microscopic Pathology.*—The bronchial wall was entirely necrosed except for a small part of the cartilage. There was also necrosis of some of the parenchyma surrounding the bronchus. Distal to this the vessels were dilated with much œdema and some hæmorrhage into the alveoli.

*Thermal Cautery*—Three-Hour Specimen. *Gross Pathology*.—A circular area of injection two to three centimetres in diameter was noted on the surface of the lobe opposite the site of cauterization. The bronchus presented a white eschar at the site of injury, with hyperæmic changes surrounding it for a distance of 1 centimetre.

*Microscopic Pathology*.—The bronchial wall had changed but little from the thirty-minute stage. Surrounding this, a pneumonic process was seen becoming manifested by the beginning infiltration of polymorphonuclear leucocytes with also a few lymphocytes. Much hæmorrhage was present, with much blood pigment scattered through the parenchyma.

*Silver Nitrate Cautery*—Three-Hour Specimen. *Gross Pathology*.—A circular area of injection 3 centimetres in diameter was noted on the surface of the lobe opposite the

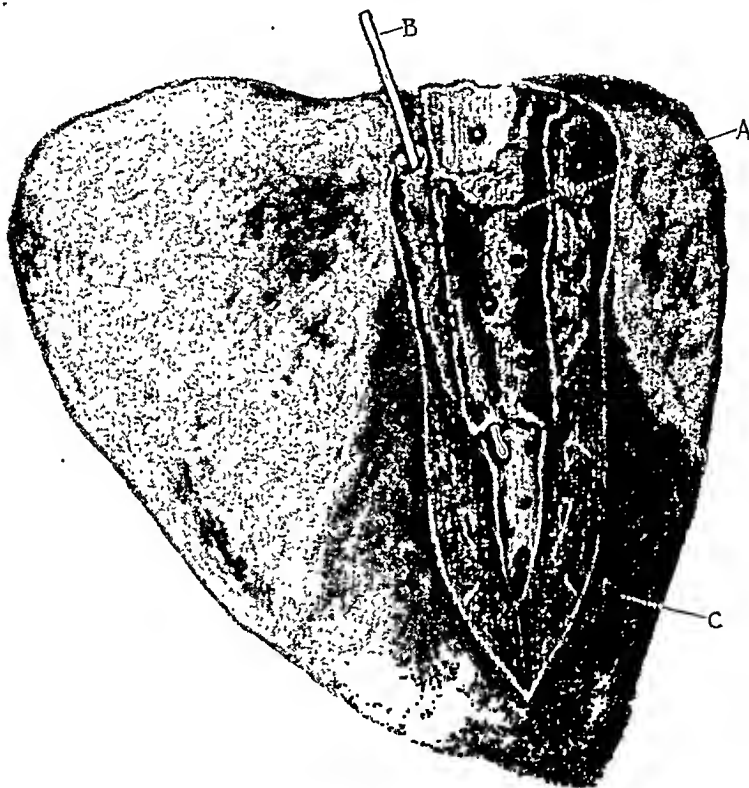


FIG. 2.—Dog No. 200A. Right lower lobe of dog dying from hæmorrhage following cauterization with silver nitrate, one day duration. Note—(A) Corrosion of bronchus at site of cauterization. (B) Probe in pulmonary artery which ruptured into bronchus. (C) Large hæmorrhagic infarct distal to site of cautery.

site of cauterization. Much corrosion of the bronchial wall at the site of injury was seen, with surrounding hyperæmic changes for a distance of 2 centimetres.

*Microscopic Pathology*.—The bronchial wall appeared the same as in the thirty-minute stage. Surrounding this the same changes as seen in the thermal cauterization of the three-hour stage, were noted. However the changes were more marked here and extended farther away from the necrosed bronchial wall.

*Thermal Cautery*—One-Day Specimen. *Gross Pathology*.—The lobe surface was injected slightly more than in the three-hour stage. The bronchial wall was seen beginning to slough at the site of cauterization, with some associated ulceration and hæmorrhage.

*Microscopic Pathology*.—The necrosed bronchial wall was seen beginning to sequestrate. Surrounding the bronchial wall both leucocytes and lymphocytes had

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FIG. 3.—Dog No. 870. Microscopic appearance of bronchial wall and surrounding parenchyma following silver nitrate cauterization, one-day duration. Note (A) Separation of necrosed bronchial wall and adjacent parenchyma from surrounding lung tissue. (B) Location for more detail study. See Fig. 4. ( $\times 35$ .)

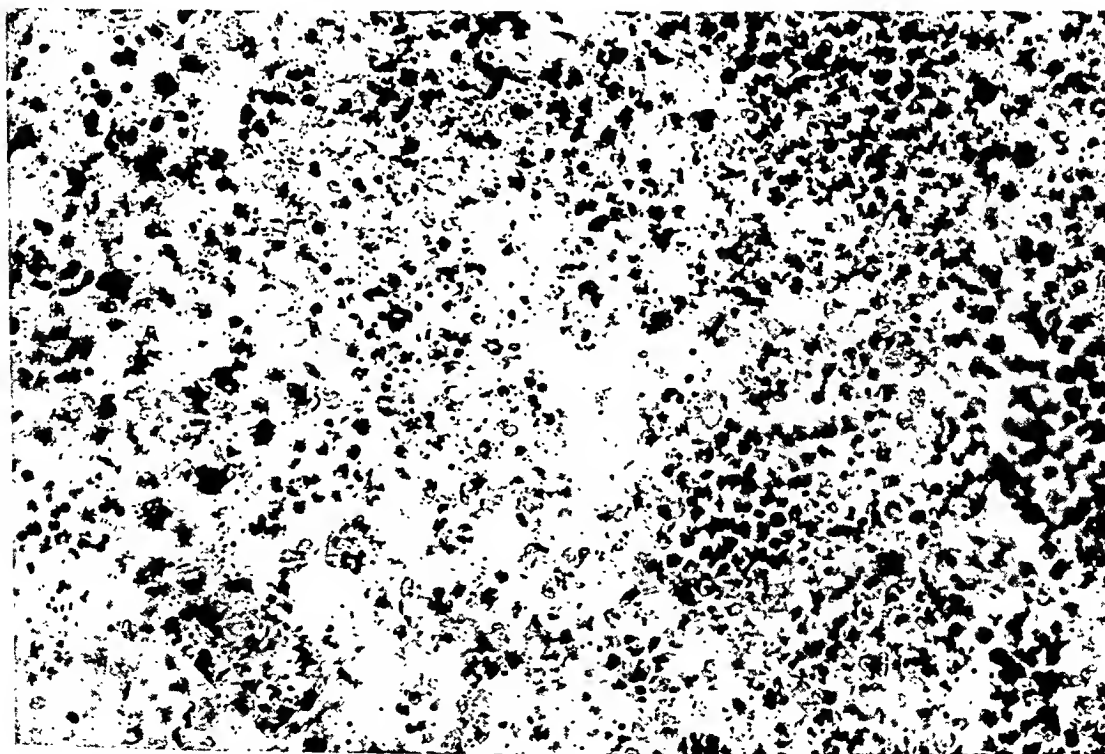


FIG. 4.—Dog No. 870. H. P. at location (B) of Fig. 3. Note leucocytic and lymphocytic infiltration with obliteration of alveolar walls.



increased in numbers since the three-hour stage, the former predominating four to one. A few large mononuclear giant cells were also present, some containing pigment.

*Silver Nitrate Cautey—One-Day Specimen. Gross Pathology.*—The surface of the lobe presented a huge solid, dark red area, a hæmorrhagic infarct. This consumed 50 to 75 per cent. of the entire lobe, with its apex located at the site of cauterization, at which point the pulmonary artery was found completely thrombosed. The necrosed bronchial wall and surrounding parenchyma at the apex of the infarct were beginning to form a sequestrum (Fig. 2).

*Microscopic Pathology.*—The bronchial wall and surrounding dead parenchyma were seen beginning to loosen from surrounding tissues. Marked leucocytic and lymphocytic infiltration (the former predominating) were present. Large mononuclear giant cells, some containing pigment, were noted throughout the pneumonic area (Figs. 3 and 4).

*Thermal Cautey—One-Week Specimen. Gross Pathology.*—The lobe surface was found deeply injected opposite the site of cauterization over an area of 1 by 4 centimetres. The bronchial wall was still in the process of sequestration at the site of injury. The surrounding parenchyma presented hæmorrhagic changes for a distance of 1 centimetre from the bronchial wall.

*Microscopic Pathology.*—The bronchial wall was still present but partly separated from the surrounding tissues. There was seen beginning regeneration of bronchial epithelium from around the cauterized area. The epithelium was a stratified type but very low, almost flattened, assimilating stratified squamous or transitional epithelium, and was found growing beneath the loosened bronchial wall. Beneath the regenerating epithelium was seen viable lung parenchyma heavily infiltrated with the pneumonic process described above. The leucocytes still predominated over the lymphocytes and the giant cells were more numerous than in the one-day stage. Also at this period there was beginning proliferation of fibroblasts, especially near the sloughing necrosed tissue (bronchial wall). In some areas a pneumonic exudate, consisting of leucocytes, red-blood cells and débris was interposed between the regenerating epithelium and lung parenchyma. This was well demonstrated by the elastic tissue stain.

*Silver Nitrate Cautey—One-Week Specimen. Gross Pathology.*—The lobe presented a large hæmorrhagic infarct consuming .8 to .9 of the entire lobe with its apex located at the site of cauterization. A bloody purulent discharge was noted coming from the bronchus. The bronchial wall and surrounding necrosed parenchyma may or may not have been completely sequestered and cast-off by this time. The pulmonary artery was completely thrombosed.

*Microscopic Pathology.*—The bronchial wall and surrounding necrosed parenchyma, if present, were found partly separated from the surrounding viable lung tissue. Epithelial regeneration was similar to that found in thermal cautey of this stage. The fibroblastic proliferation beneath the epithelium was much more marked here than that found in the thermal cautey, as also was the pneumonic process, which extended farther from the necrosed bronchial wall. (The epithelium was the only part of the bronchial wall seen to regenerate where either type of cautey was used.) (Figs. 5 and 6.)

*Thermal Cautey—Two-Week Specimen. Gross Pathology.*—A somewhat pale and slightly elevated circular area about one inch in diameter was seen on the surface of the lobe opposite the site of cauterization. The bronchial lumen was somewhat constricted at the proximal edge of the injured area with dilatation distal to it, about 1.5 times the diameter of the bronchus, which was filled with a mucopurulent material (Fig. 7).

*Microscopic Pathology.*—The necrosed tissue had sloughed away. Fibroblastic proliferation was quite marked. Little evidence of hæmorrhage remained. There was more or less granulation tissue interposed between the parenchyma and the newly regenerated epithelium. Lymphocytes predominated over the polymorphs at this stage

## REPAIR OF BRONCHIAL INJURIES



FIG. 5.—Dog No. 119A. Microscopic appearance of bronchial wall and surrounding parenchyma following silver nitrate cauterization, one week duration. Note (A) Regenerating epithelium. (B) Cartilages not cast off. (C) Uninjured bronchus. ( $\times 35$ .)

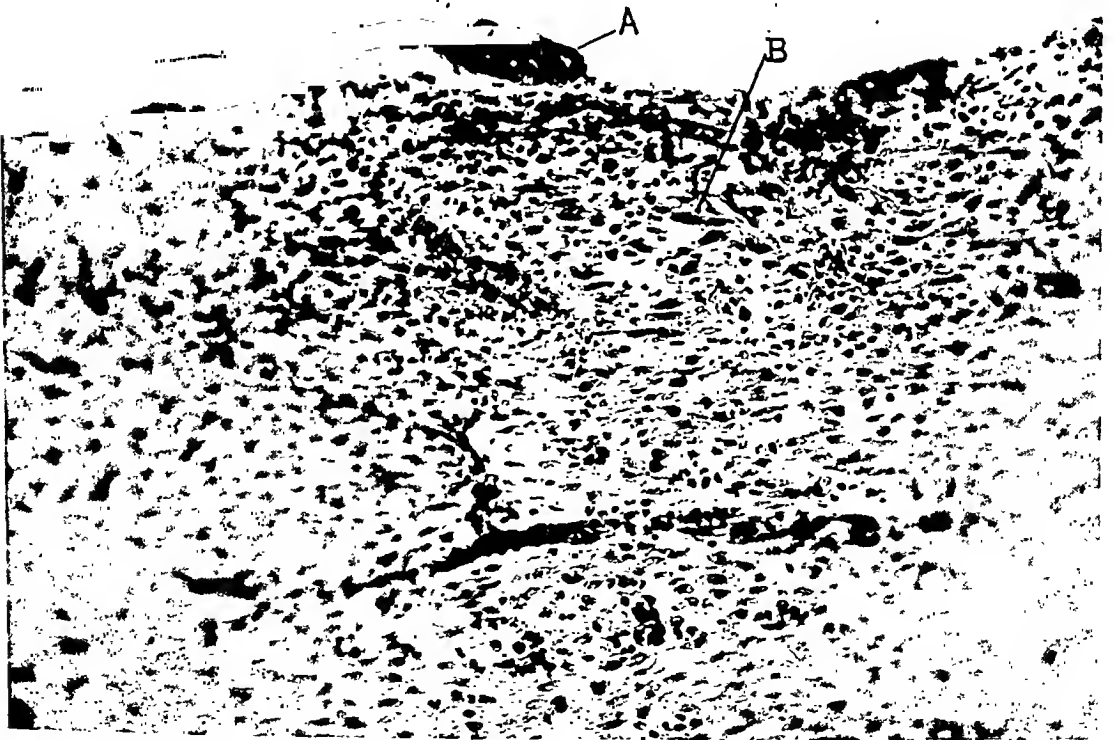


FIG. 6.—Dog No. 119A. H. P. at (A) Fig. 5. Note (A) Regenerating epithelium. (B) Fibroblasts.

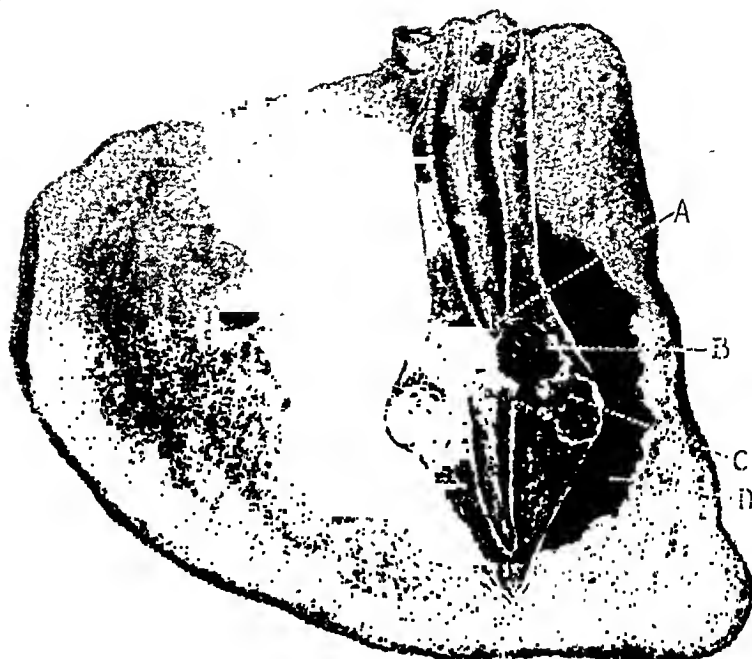


FIG. 7.—Dog No. 135A. Right lower lobe having received thermal cautery. Two days' duration. Note (A) Partial stenosis of bronchus. (B) Dilatation distal to stenosis with lack of cartilages. (C) Small abscess cavity communicating with dilatation. (D) Superficial fibrosis (not an infarct).

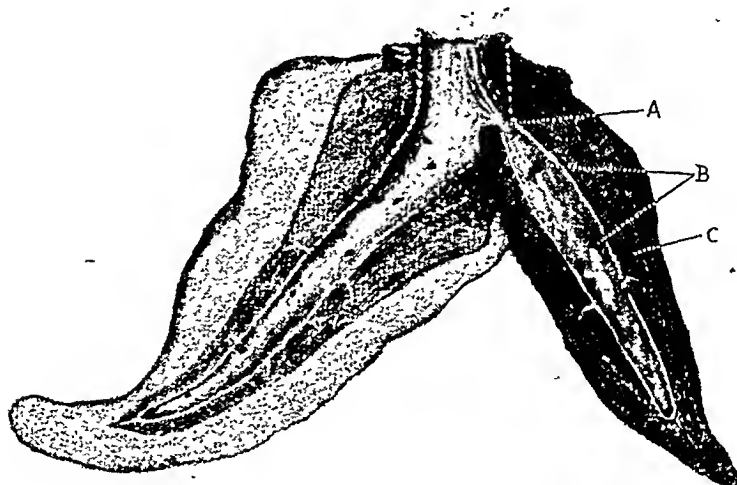


FIG. 8.—Dog No. 89A. Accessory lobe, one secondary bronchus of which received silver nitrate cautery, one-month duration. Note (A) Marked stenosis filled with a mucogelatinous substance. (C) Massive atelectasis of lobe distal to stenosis.

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except where groups of polymorphs were noted here and there (small abscesses). The giant cells had increased in number.

*Silver Nitrate Caутery*—Two-Week Specimen. *Gross Pathology*.—A large hæmorrhagic infarct was still present. The bronchus was filled with a bloody discharge. The bronchial lumen was somewhat constricted at the proximal edge of the injured area, with a dilatation just beyond, 1.5 times the diameter of the bronchial lumen.

*Microscopic Pathology*.—The changes here were the same as those seen in thermal cautery at this stage. However, the fibroblastic proliferation was more pronounced and the process more extensive in the case of silver nitrate cauterization.

*Thermal Caутery*—Three to Four Weeks' Specimen. *Gross Pathology*.—The surface of the lobe appeared normal. The bronchial lumen was somewhat constricted at the proximal edge of the injured area with a dilatation distal to it filled with a mucogelatinous material. There was evidence of surrounding inflammation for a distance of 1 centimetre.

*Microscopic Pathology*.—The epithelium was completely regenerated. Surrounding fibrous tissue had replaced the other tissues of the bronchial wall. Lymphocytes and giant cells were still present.

*Silver Nitrate Caутery*—Three to Four Weeks' Specimen. *Gross Pathology*.—Two varieties of results were seen at this stage, *vis.*: 1. Much shrinkage and scarring of the lobe distal to the site of



FIG. 9.—Dog No. 198A. Microscopic appearance following silver nitrate cauterization, three weeks' duration. Note (A) Regenerated epithelium. (B) Fibroblastic zone. (C) Lymphocytic zone. (D) Giant cells. Very few polymorphonuclear leucocytes present. (x 290.)

injury was seen. Bronchial stenosis was incomplete to complete. The pulmonary artery was thrombosed. 2. The surface of the lobe appeared almost normal. Bronchial stenosis was incomplete to complete. The lobe at times presented massive atelectasis distal to the stenosis. Larger air passages distal to the stenosis were dilated and filled with a dirty mucogelatinous material. The pulmonary artery was intact (Fig. 8).

*Microscopic Pathology*.—1. The epithelium was completely regenerated. Very much fibrous tissue surrounded the newly formed bronchial lumen and extended out to the lobe surface. Some round cells and giant cells were still present. 2. This differed from 1 in that the fibrous tissue extended for only 1 centimetre away from the bronchial wall and the alveoli distal to the stenosed bronchus were at times collapsed (Fig. 9).

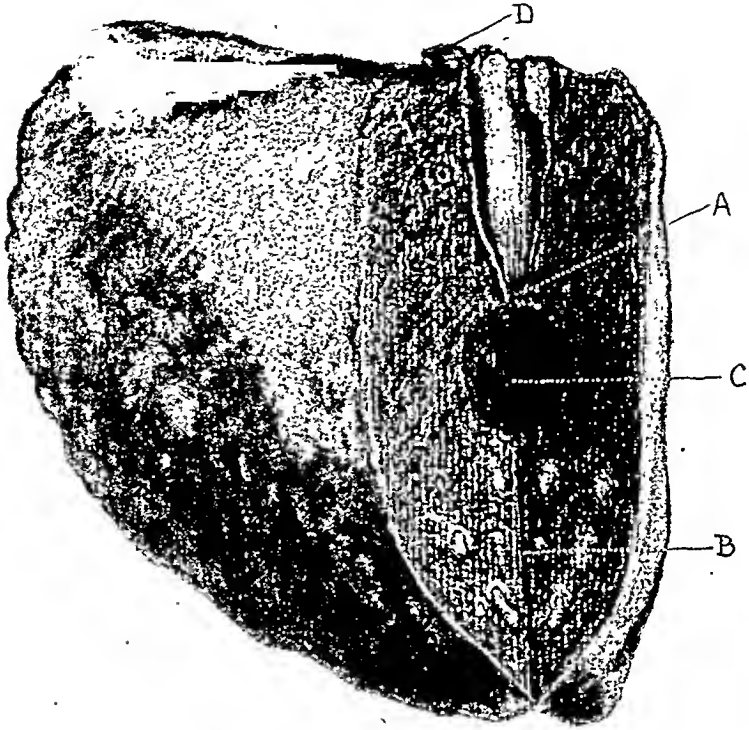


FIG. 10.—Dog No. 122A. Right lower lobe having received silver nitrate cautery, duration six weeks. Note (A) Complete stenosis of bronchus. (B) Normal air containing parenchyma but larger passages filled with mucogelatinous material. (C) Reorganizing area. (D) Pulmonary artery.

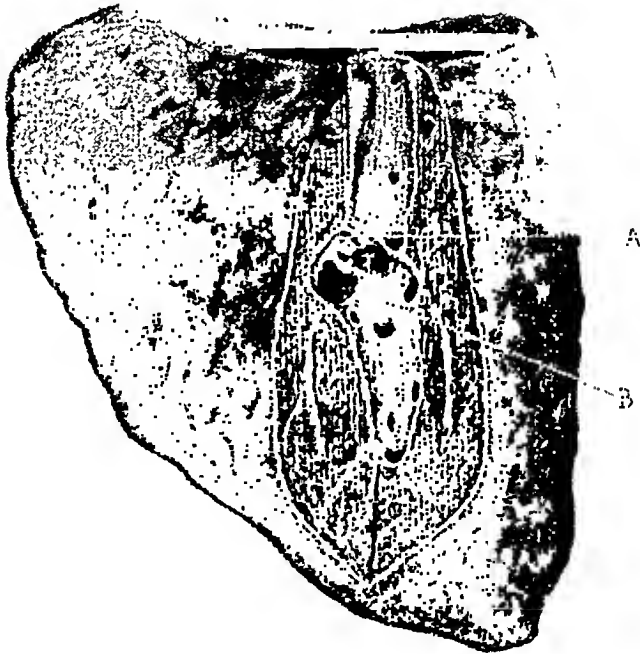


FIG. 11.—Dog No. 121A. Right lower lobe having received silver nitrate cautery, duration six weeks. Note (A) Partial stenosis of bronchus. (B) Dilatation distal to stenosis.

## REPAIR OF BRONCHIAL INJURIES

*Thermal Cautey*—Six-Week Specimen. *Gross Pathology*.—The surface of the lobe appeared normal. There was partial stenosis of the bronchus which presented a scarred appearance. (Lobe was somewhat shrunken in some cases.)

*Microscopic Pathology*.—Very little change was seen from that of the four-week stage. More fibrosis was present, but it was confined to the region immediately surrounding the bronchus. Giant cells and round cells were still present.

*Silver Nitrate Cautey*—Six-Week Specimen. *Gross Pathology*.—No. 1 of four-week stage. The lobe was much shrunken and was firm and rubbery in consistency. The pulmonary artery was thrombosed, the bronchus was completely stenosed. No. 2. The lobe surface appeared normal. Bronchial stenosis was incomplete to complete. Massive atelectasis was present at times distal to the stenosis. The larger air passages distal to the stenosis contained a dirty mucogelatinous material (Figs. 10 and 11).

*Microscopic Pathology*.—Little change from four-week stage was noted. The lymphocytes appeared to form a wall around the bronchus with much organizing fibrous tissue between it and the bronchial epithelium. In No. 1, the fibrous tissue extended out to the lobe surface. Giant cells were still present. (Fig. 12.)

*Thermal Cautey*—Eight-Week Specimen. *Gross Pathology*.—The surface of the lobe appeared normal. Bronchial stenosis was present, usually incomplete, at the proximal edge of the injured area, with dilatation distal to the stenosis.

*Microscopic Pathology*.—The pulmonary artery was intact. The entire bronchial wall was lacking except for the newly regenerated epithelium, which was a flat stratified type and lay on a fibrous tissue base.

*Silver Nitrate Cautey*—Eight-Week Specimen (two types of results). *Gross Pathology*.—1. The lobe was much shrunken and fibrotic. There was complete stenosis of the bronchus (Fig. 13). 2. The lung lobe appeared normal or atelectatic. Bronchial stenosis was incomplete to complete, with dilatation distal to the stenosis. The air passages beyond the stenosis usually contained a dirty mucogelatinous material.

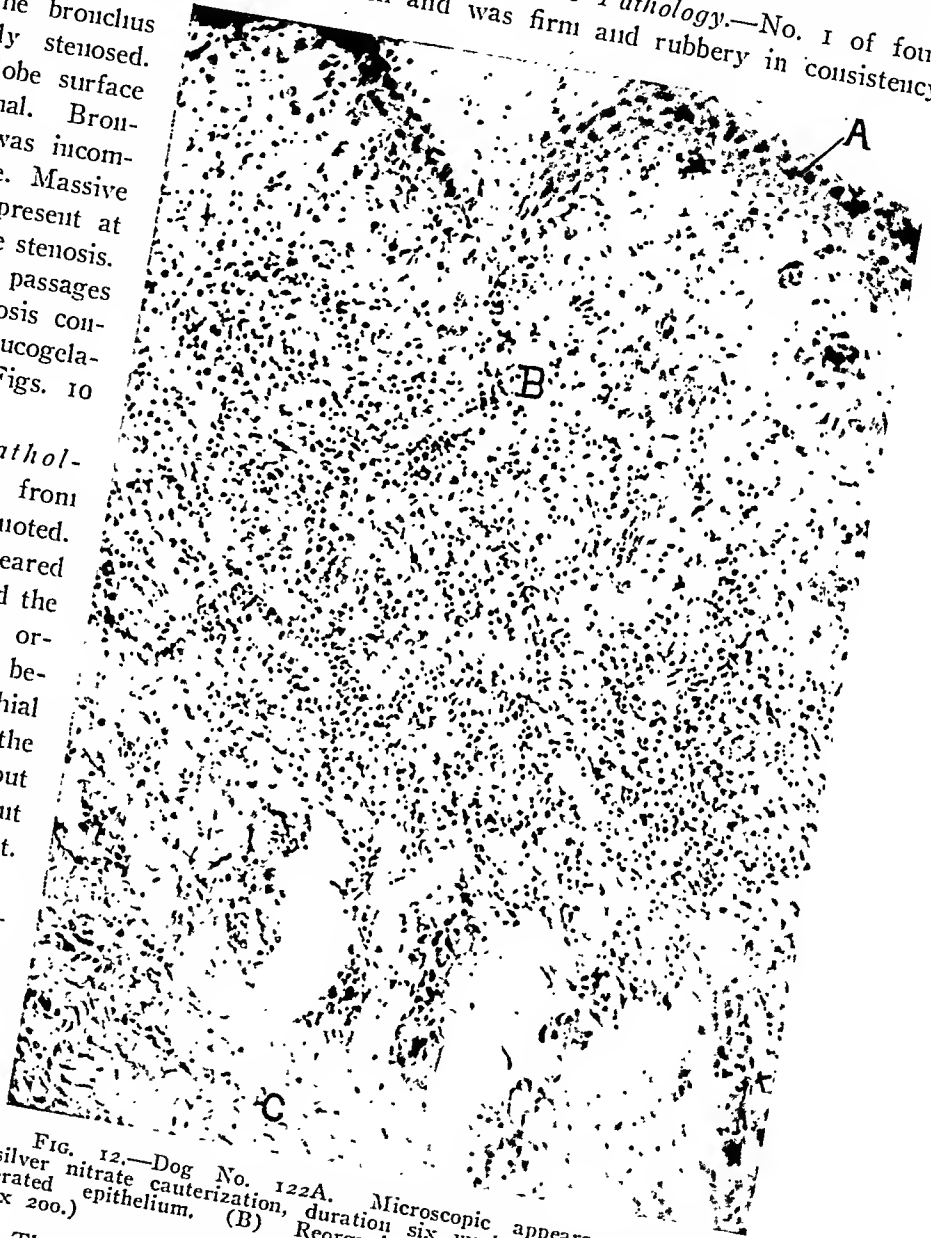


FIG. 12.—Dog No. 122A. Microscopic appearance following silver nitrate cauterization, duration six weeks. Note (A) Regenerated epithelium. (B) Reorganization. (C) Fibrous tissue. (x 200.)

*Microscopic Pathology.*—In both 1 and 2 the entire bronchial wall was lacking except for the regenerated epithelium, which was composed of several layers of flattened cells and lay on a fibrous tissue base. In 1 this fibrous tissue extended to the surface of the lobe (Fig. 14).

*Repeated Thermal Cauterization.—Gross Pathology.*—The surface of the lobe appeared entirely normal. The bronchus was completely stenosed at the site of cauterization. Pulmonary vessels were intact.

*Microscopic Pathology.*—The bronchial wall at the site of injury was composed of white fibrous connective tissue with pieces of dead cartilage scattered throughout. A fibrous connective tissue septum, lined on either side by a low stratified epithelium, stretched across the bronchial lumen, totally obstructing the passage of air (Fig. 15).

FIG. 13A.—Dog No. 896. Right lower lobe, two views, A and B. Silver nitrate cautery, duration two months.

*Discussion.*—The results given above are those which usually follow this type of injury. However it is readily understood how variations may occur with slight changes in the fundamental factors, *i.e.*, in one dog a small abscess formed just beneath the surface of the lobe and communicated with the bronchial dilatation at the site of injury as the result of liquefaction and sloughing rather than reorganization. Another dog's lung showed the pulmonary artery wall adjacent to the cauterized bronchus to consist of a thin partition of granulation tissue stretched between the bronchus and the artery, the arterial lumen being intact. A third, and more commonly seen variation, was massive atelectasis in the lobe, distal to the partially stenosed bronchus. Our view

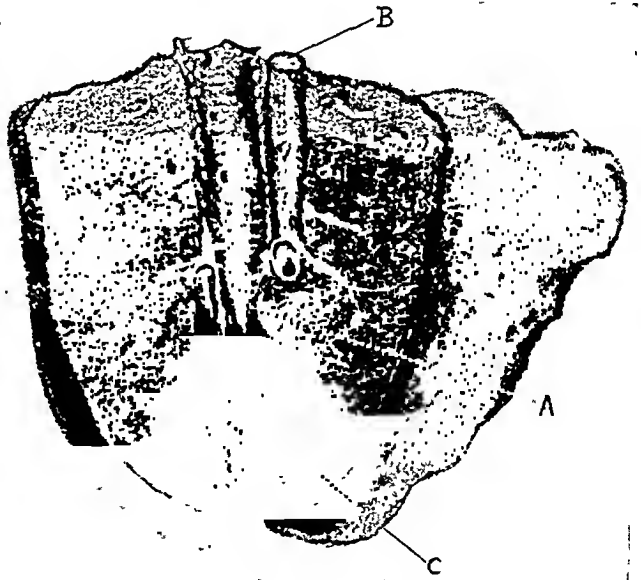


FIG. 13B.—Note (A) Complete stenosis of bronchus. (B) Pulmonary artery. (C) Fibrous tissue. Slow organization in centre.



## REPAIR OF BRONCHIAL INJURIES

concerning the mechanism of production of this collapse is given in another publication.<sup>14</sup>

The reparative processes following an injury to a bronchus depend upon the severity of the injury, both to the bronchial wall and to the vascular supply of the lung lobe. It is to be noted that the damaging agent caused a complete necrosis of the bronchial wall, with regeneration of only the epithelial lining. This failure of the bronchial wall, other than the epithelium, to regenerate, may explain the cause of failure to obtain a satisfactory closure of the stump in lobectomies and pneumectomies where little or no peribronchial tissue covers the stump (as suggested by Bettman).

In the case of silver nitrate cautery, the adjacent peribronchial parenchyma was also destroyed and cast off. The resulting stenosis of the bronchus occurred at the proximal end of the injured area, while the accompanying dilatation was just distal to the stenosis and in the region of greatest destruction. This leads one to believe it was a passive rather than an active dilatation.

As to blood-vessel damage, thermal cautery never produced thrombosis of the pulmonary artery, while



FIG. 14.—Dog No. 896. Microscopic appearance following silver nitrate cautery, duration two months. (A) Regenerated epithelium. (B) Fibrosis. (x 200.)

silver nitrate was always followed by thrombosis and hæmorrhagic infarct formation within twenty-four hours. In later stages, it is to be noted, the infarcted area either became fibrosed or resolved into fairly normal air-containing parenchyma, depending upon the restoration of the vascular supply; perhaps both time and degree of revascularization. At times there was a piling up of organizing pneumonic exudate, which was lined by the



regenerating epithelium, thus forming polyps. This was noted by Winternitz<sup>15</sup> in his work with hydrochloric acid insufflation in rabbits. He also found the epithelium to regenerate very rapidly, at times forming inclusions extending beneath the surface of the air-passageway wall.

The rapidity of the regeneration of the lining epithelium, together with the lack of regeneration of the other tissues of the bronchial wall, may throw some light on the cause of failure of many persistent bronchial fistulas to respond to therapeutic measures. Work is being carried out on this problem at the present time, which will appear in a subsequent publication.

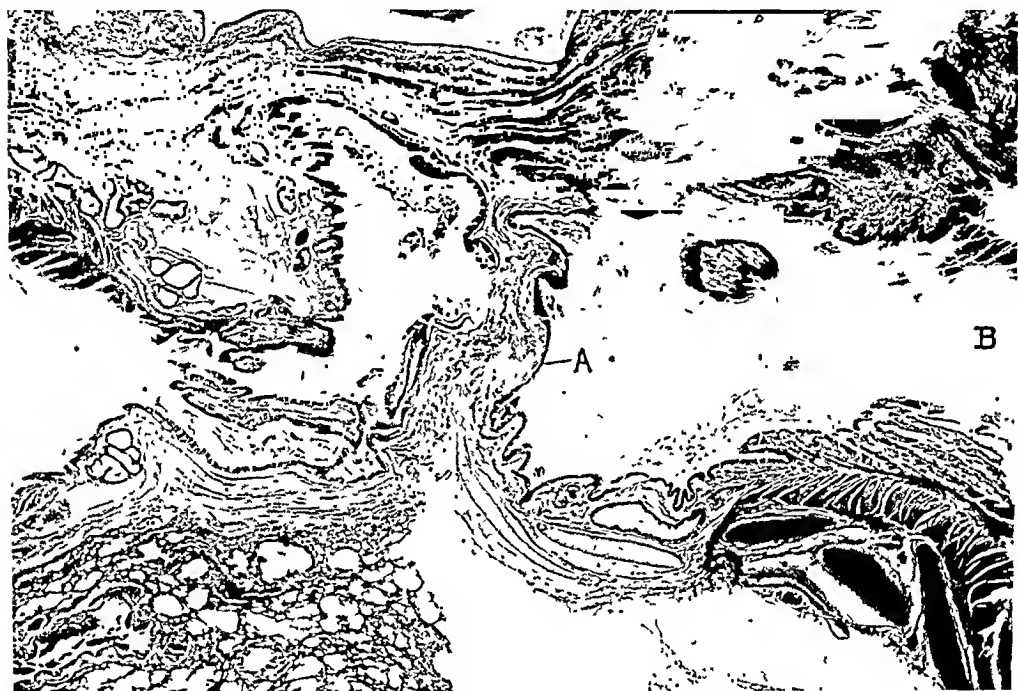


FIG. 15.—Dog No. 935. Microscopic appearance following repeated thermal cauterization over period of approximately six months. (A) Fibrous tissue septum lined by epithelium producing complete obstruction. (B) Origin of bronchus (x 25.)

A brief summary of the comparison of the two types of cautery follows:

	Thermal bronchial wall necrosis	Silver nitrate bronchial wall necrosis; adjacent parenchymal necrosis; blood-vessel damage
1. Degree of injury		
2. Thrombosis of pulmonary artery	never	always
3. Degree of early reaction	moderate	marked
4. Infarct formation	never	always
5. Regeneration of epithelium	early	early
6. Regeneration of bronchial wall other than epithelium	none	none
7. Degree of fibroblastic reaction	moderate	marked

Repeated thermal cauterization resulted in complete stenosis of the bronchial lumen. Although only two dogs were treated in this manner, the results were the same in both.

## REPAIR OF BRONCHIAL INJURIES

The production of stenosis was a very gradual process which, in a bronchus with a lumen of .4 inches in diameter, extended over a period of approximately six months. Two factors were concerned in this process, *viz.*: the production of granulation tissue within the bronchial lumen; and fibroblastic proliferation around the bronchial wall with fibrous tissue formation.

In view of these findings it is logical to believe that persistent bronchial fistulæ may be permanently closed by means of repeated thermal cauterization.

### CONCLUSIONS

1. Silver nitrate and thermal cautery may produce very similar lesions and stimulate very similar reactions when applied to a bronchus.

2. An injury due to one of the above agents, sufficient to destroy the entire bronchial wall, may produce the following changes:

a. Sequestration and sloughing of the entire thickness of bronchial wall in one to two weeks.

b. Hæmorrhagic infarction within twenty-four hours after the use of silver nitrate.

c. A pneumonic process which either resolves or goes on to various degrees of fibrosis.

d. Regeneration of a low stratified epithelium within six days (before sequestered wall has sloughed away).

e. No regeneration of bronchial wall other than epithelium.

f. Much fibrous tissue formation at site of cautery.

g. Stenosis of bronchial lumen, incomplete to complete, accompanied by dilatation of the bronchial lumen just distal to the stenosis.

h. Air passages distal to a completely stenosed bronchial lumen filled with a dirty mucogelatinous material.

3. Repeated thermal cauterization results in complete stenosis of the bronchial lumen, the process extending over a period of months depending upon the size of the bronchus.

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# MORTALITY AND END RESULTS OF OPERATION FOR ABSCESS OF THE LUNG\*

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THE treatment of lung abscess has been considered in recent years so carefully, and from so many different angles that we are in a fair way to a better understanding of the many complicating factors concerned. It is essential for the surgeon to understand the etiologic factors responsible for the abscess and particularly the possibility of foreign body obstruction of a bronchus, the pathologic nature of the process, the extent of associated bronchiectasis, the presence of multiple cavities, the existence of a gangrenous wall, etc., if he wishes to obtain the best results from treatment.

Recognizing that drainage of the collection is the means by which cure is obtained and that a residual bronchiectasis may be responsible for recurrence, it is apparent that either the bronchial tubes, or an external opening may be used for drainage and that compression or removal of the affected part of the lung may be necessary to prevent recurrence. As this paper is concerned only with the results of external drainage most of the details regarding other methods of treatment will not be considered.

In any case of lung abscess, rest in bed, postural drainage, and bronchoscopic aspiration must be considered as primary treatment. Some patients undoubtedly recover spontaneously and Lord (*Boston M. and S. Jour.*, 1927, vol. cxcvii, p. 333) estimates this as 10 per cent. Graham (*Archives Surg.*, 1927, vol. lxxxvi, p. 174) says that in his experience, 25 per cent. or more heal spontaneously. Posture undoubtedly favors drainage of the abscess and in favorable cases the approximation of the granulating walls permit healing, Lord believes that if the disease has lasted eight weeks or less, the chances of recovery are about 20 per cent., but if the process has lasted a longer time than this there is little to be expected from palliative measures.

Bronchoscopic aspiration has proved its worth. With due consideration of the spontaneous cure of many cases, and the effect of rest and postural drainage there is no doubt but that additional relief can be given by the bronchoscope. Eliminating those cases of suppuration associated with foreign body in the bronchus which always indicate bronchoscopy, the presence of pus in the bronchi in a case of proved lung abscess usually means that some drainage is occurring. The bronchoscope acts by removing heavy plugs of mucus or pus, thus providing better drainage. Kramer (*Surg. Clinics North America*, 1928, vol. viii, p. 377) reports 27 per cent. of cures in 105 patients,

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\* Read before the Philadelphia Academy of Surgery, December 2, 1929.

observed for a period of six months or more. Kernan (Arch. Surg., 1928, vol. xvi, p. 215) considers 45.5 per cent. of 68 patients as cured by bronchoscopy and Clérif (Atlantic Med. J., 1928, vol. xxxi, p. 911) reports 51 per cent. of cures after bronchoscopic treatment of lung abscess following tonsillectomy. Clérif also noted that 79 per cent. of his patients were cured in whom the treatment was instituted within three months after the onset of symptoms.

The status of artificial pneumothorax is not clear. I would judge that it might be worth-while in the occasional patient with a non-adherent lung, a single cavity, especially one near the hilum, and a free bronchial outlet. It has possibilities of great danger in peripheral abscess from rupture of adhesions. Arsphenamine is useful in cases with fetid sputum and when spirochetes are present in the sputum.

External drainage will be found necessary in about 50 per cent. of patients suffering from lung abscess, although in clinics where expert broncho-

TABLE I  
*Fatal Cases*

Etiology	Age	Location	Duration	Death
1. Tonsil.....	25	R.L.	10 weeks	Sudden collapse. 12 days
2. Pneumonia.....	36	R.U.	14 months	Abscess other lung. 2 days
3. Pneumonia.....	75	R.U.	6 months	Gang. extremities. 23 days
4. Pneumonia.....	51	R.L.	6 weeks	Pneumonia. 17 days
5. Broncho. Pneumonia	47	R.U.	1 month	Abscess other lung. 37 days
6. Pneumonia.....	63	R.U.	2 weeks	Abscess other lung. 2 months
7. Tonsil.....	9	R.L.	5 months	Cerebral abscess. 1 month
8. Broncho. Pneumonia.	67	R.U.	6 weeks	Pyo-pneumothorax
9. Broncho. Pneumonia.	46	R.U.	3 months	Cerebral abscess. 12 days
10. Tonsil.....	54	R.U.	1 month	Abscess other lung. 1 month

scopic treatment is given, this number may be lessened if there are many of the post-tonsillectomy cases. Generally we should advise operation in cases of peripheral abscess with pleural involvement or with empyema, in multiple abscess, or lobar bronchiectasis, and after a trial of several months of postural drainage supplemented by bronchoscopic aspiration. I also believe that in those cases of well localized single abscess with good surrounding lung, external drainage is safe and effects a more rapid cure. Each patient must be treated as an individual and treatment advised after careful study and a preliminary bronchoscopy.

*Mortality.*—Most clinicians and bronchoscopists take a pessimistic attitude towards operation and no doubt this has been brought about by the high mortality attending it. There are many series of cases on record, but a review of the literature indicates an average mortality of 35 per cent. The incidence of death from operation depends upon the condition of the patient and the proper selection of the time for operation. During a period of seven years (1922–1928) thirty-five patients have been referred to my service in the Hospital of the University of Pennsylvania for external drainage of a

## RESULTS OF OPERATIONS FOR ABSCESS OF LUNG

lung abscess. Practically all had been under conservative treatment previously and many treated by bronchoscopic aspiration. There were ten deaths (28.5 per cent.) but the subjoined table indicates the serious nature of the infection in these cases.

Four patients had involvement of both lungs and in one, nothing was done except the preliminary stage of rib removal under local anæsthesia. Two patients died of cerebral embolus and one of these was apparently well and up in a wheel chair when stricken with the hemiplegia. He was operated on by Doctor Frazier but succumbed. Another patient was an old woman of seventy-five years. She was a poor risk and probably should not have been operated on; pulmonary œdema and toe gangrene were terminal affections. Seven of these patients, therefore, were nearly hopelessly handicapped.

TABLE II  
*Age Relation to Mortality*

	All Cases	Tonsil Group	Others
Recovery.....	35	13	22
Deaths.....	10	3	7
Per cent.....	28.5	23	32
Total average age.....	36 years	29 years	44 years
Fatal cases.....	47 "	29 "	55 "

	Cases	Deaths	Mortality
Average age, 36.3 years...			
36 years or less.....	19	3	16 per cent.
Over 36 years.....	16	7	44 " "
Mean age, 35 years.....			
Below 35 years.....	17	2	12 " "
Over 35 years.....	17	8	47 " "

Another patient was operated upon seven months after onset of symptoms following tonsillectomy. The operation was done in two stages and the abscess easily drained. Eight days later she suddenly developed symptoms of shock and died in twenty-four hours. No post-mortem was obtained but the symptoms were not cerebral. The pulse was always very rapid. The operation was done in 1922 and ether anæsthesia was used for the first stage and the lung sutured to the parietal peritoneum. Both of these procedures were abandoned that year. The ninth death occurred in a patient who had a large abscess in the lower right lobe. Apparently the operation was properly conducted and for six days after drainage the temperature was normal and the pulse low. Signs of a spreading lung involvement then appeared with death three days later. Autopsy refused. The tenth death was due to bad management. The patient was sixty-seven years old and quite ill. He was operated upon too soon. The abscess was not properly located and the

pleura opened during the evacuation of the abscess. Later he developed a pyo-pneumothorax and died from this because at autopsy the abscess was found perfectly drained. Therefore, in a review of this list we feel that in two cases death might have been avoided, but that in the others we were helpless to prevent it.

I have been struck by another factor in studying mortality and that is the influence of age. Lilienthal (Arch. Surg., 1928, vol. xvi, p. 206) mentions this, the mortality in his series being 42 per cent. in those under fifty and 63 per cent. in those above that level. In this series the mortality of operation in 27 patients under fifty years was 18.5 per cent., whereas in eight over fifty it was 62.5 per cent.

*End Results.*—Careful studies of the end results of operation are rarely noted in the literature. In a series of 100 cases reported by Miller and Lambert (Amer. J. Med. Sc., 1926, vol. clxxi, p. 81) 47 were operated upon with 19 death and 20 cures (42.5 per cent.). In the group of cases reported in this paper there are 14 cures (40 per cent.). By this is meant that the present condition of every patient has been obtained and many have been personally examined, all at least one year since operation.

TABLE III  
*End Results*

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25 patients survived operation
14 are cured. 40 per cent. of total. 56 per cent. of survivals
7 patients show varying grades of improvement
4 later deaths. Final mortality 40 per cent.

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In the cured group the patients have been operated upon a period of one year to six years and seven months. They now have no cough or expectoration, no sinus and are able to work. Most have been checked by röntgen examination. The trunk shadows are usually increased, the diaphragm usually high and fibrosis is suggested.

In the "improved" group two patients seem cured of the abscess. Both have been operated upon over six years but they still speak of cough and some expectoration at times and neither is able to do much work. One of these patients, forty-five years old at the time of operation, had had an unproductive winter cough for twenty-two years. He was operated upon in May, 1923, and now in November, 1929, still has cough and some râles, but is otherwise well. The other, fifty-four years old, was also troubled with cough for years. He was operated upon in October, 1922, still has cough and expectoration, some myocardial disease and attacks of dyspnoea. From the surgical point of view these patients are cured, but clinically are not well.

In a third patient a left lower lobe abscess was complicated by a bilateral lesion and demonstrated tuberculosis. The abscess was drained. Two years later he is markedly improved, but is in a sanatorium. The abscess on the

## RESULTS OF OPERATIONS FOR ABSCESS OF LUNG

side operated has healed. A fourth patient developed abscess after pneumonia and was operated upon one year later. Drainage was followed by a cautery operation. About fourteen months later the sinus has healed; there is still cough and slight expectoration; there is no fever and hemoptysis, and while X-ray shows a small cavity the appearance is that of great improvement.

The other three patients are still suffering from suppuration in the lungs. They have drainage, cough and expectoration, attacks of fever and X-ray evidence of multiple cavitation. All have had cautery operations, but are in need of further surgical treatment. They are in no immediate danger, but probably, sooner or later, will die from the lung affection. Two of these patients had the first operation eighteen months ago, and in one, a year has elapsed.

Finally, regarding those patients who succumbed after discharge from the hospital.

TABLE IV  
*End Results*

	All Cases	Tonsil Group	Others
Final mortality.....	40 per cent.	31 per cent.	45.5 per cent.
"Improved".....	20 per cent.	15 per cent.	22.5 per cent.
Cured.....	40 per cent.	54 per cent.	32 per cent.

One patient was a man, thirty-seven years of age, who had pneumonia ten weeks before admission. He came in with symptoms and signs of abscess. This was easily evacuated and the patient made a slow recovery. However, he had a bronchial fistula and was re-examined in December, 1922, at which time he had some cough and expectoration. We heard nothing further until this follow-up was begun when it was reported that he had died in January, 1923, eleven months after operation, from "pneumonia." Undoubtedly his death resulted from a continuance of the original disease.

The second case was a man of sixty, whose lesion had existed five months, following a chronic cough of many years. I evacuated the abscess in the left upper lobe and at the time suspected malignancy of the lung. He had a bronchial fistula at the time of drainage and six months later died, his physician stating that the drainage had continued and that "death was not unlike a case of pulmonary tuberculosis."

A third patient developed an abscess after tonsillectomy and was admitted to the hospital thirteen months later. An abscess in the left upper lobe was opened, a secondary pocket subsequently cauterized, and later she seemed in fairly good condition and was sent home. She then went West, but her physician writes that she died from continued trouble in the lung about a year after the original operation.

The fourth patient was operated upon for a left lower lobe abscess following pneumonia. Three months later there was evidence of a suppurative condition in the left upper and right lower lobes. Bronchoscopic treatment was given, but during an intermission the patient died suddenly from cerebral manifestations. No autopsy was obtained.

A fifth patient was operated upon in September, 1926, for a right upper lobe abscess following tonsillectomy. He was sixty-three years of age. He seemed to have done well for a while, but died in March, 1928, from a cause unknown.

These five patients and the three patients who are hanging on in a slightly improved or unimproved condition, constitute a group of patients



difficult to treat. Lilienthal states that, "if recovery is not complete, whether or not operation has been performed, the possibility is that the patient will finally succumb to his disease or to its sequelæ," as he well says, "one must not be deceived by discharge of a living patient from the hospital."

After external drainage has given relief from sepsis and cough and expectoration has lessened, a careful review with the X-ray is necessary to exclude the existence of multiple cavity. Sometimes this can be determined in the wound with a light. If such exists the surgeon must plan an early cautery operation after the method of Graham. Only by breaking down all pockets can we expect to cure this group, otherwise they leave the hospital "improved," only to suffer from a recurrence. During four years Graham (*Arch. Surg.*, 1929, vol. xviii, p. 531) operated on 45 patients by this method, of which 24 per cent. died later from various causes, the hospital mortality being 6.6 per cent.

This paper would be incomplete without mention of lobectomy. It may be that we will find this the best procedure in cases of multiple cavity and limited bronchiectasis. During the period covered by this paper I had not performed lobectomy for pulmonary suppuration.

#### CONCLUSIONS

1. Lung abscess is a serious disease and the end result of a group of patients can only be determined a long time after treatment.

2. External drainage is indicated (1) after failure of conservative measures, (2) in peripheral abscess with pleural involvement (3) in multiple abscess.

3. Cautery excision or lobectomy is indicated in (1) multiple abscess and (2) in abscess with lobar bronchiectasis.

4. A series of cases is reported with an operative mortality of 28.5 per cent. and a final mortality of 40 per cent. Fifty-six per cent. of the survivors are clinically well. Two patients recovered from the abscess, but still have the cough they had for many years, giving 64 per cent. of satisfactory results in the survivors.

5. Those patients who survive the operation, but who do not get permanently well will be likely to succumb to the effects of the disease. Perhaps an increased use of the cautery method of extirpation of the diseased area, done early, may result in a greater percentage of ultimate cures, even though the immediate mortality may be higher.

# DIAPHRAGMATIC HERNIA

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A REVIEW OF THE LITERATURE AND ETIOLOGY OF THE CONDITION, WITH A REPORT OF FOUR PERSONAL CASES

DIAPHRAGMATIC hernia has been largely in evidence in both American and foreign medical literature the last few years. Sisk<sup>1</sup> computes that about one thousand cases have been published since 1920. Nevertheless, this condition wears such a number of faces, both clinically and on the operating table, that something may still be learned from each new case reported in full. This point was recently urged by Haberer,<sup>2</sup> who refused to preface his case history with an apology and deplores the possibility of any such case being lost in statistical summaries before it has been published in detail.

Prior to the use of the röntgen ray, a diagnosis of diaphragmatic hernia was made in only one or two instances before the opening of the body, but in the last few years the condition has been correctly diagnosed in a number of cases on clinical grounds alone and even by the general practitioner.<sup>3</sup> This advance in diagnostic feasibility has been made possible by the many complete and thoughtful case reports that have been published, in which the symptoms, bewildering in their variations from case to case, have been interpreted in the light of the röntgenogram and screen examination and by the details of anatomic and functional derangement exposed at operation or autopsy.

As we become more familiar with this condition, we find that it is not as rare as was formerly supposed. From a surprise of the operating room or a curiosity of the autopsy report, it has become a possibility to be considered, routinely, in every case with unexplained symptoms referable to the heart or lungs or to the digestive system. Importance should not be attached to the fact that the symptoms have begun in adult life with no trauma in the recent history. Diaphragmatic hernia of congenital origin may become manifest at any age, and when trauma is the cause years may elapse between the injury and the onset of symptoms of the hernia.

The cause of congenital diaphragmatic hernia is the failure of the component parts of the diaphragm, growing out toward each other, to meet and unite. If this developmental failure occurs before the membranous diaphragm is complete, the defect will be total and the thoracic and abdominal cavities will be in free communication. The hernia will be without a sac—a so-called "false" hernia. If, on the other hand, it occurs later, during the formation of the muscular diaphragm, a layer of apposed pleura and peritoneum will separate the cavities and will form a sac for the ascending abdominal viscera. In the first type, it is probable that the herniation of the organs takes place during intra-uterine life, even when symptoms do not appear till late. The viscera acquire tolerance for their crowded condition and,

since they can move more freely, there is less danger of strangulation or kinking than when they are confined in a sac. In the second case, the herniation may not take place till long after birth. Indeed, if the defect is small, it may never take place. The diaphragm contains a weak spot and under some unusual condition of internal tension the hernia may at any time occur or it may develop gradually. Thus it is usual to consider all cases of diaphragmatic hernia in which there is no history of a penetrating wound or of external violence to the lower thorax or upper abdomen as of congenital origin, but the term "acquired" hernia, used by Hedblom<sup>4</sup> is, perhaps, preferable for hernias that take place slowly, at any time after birth, through an anatomically weak area, such as the oesophageal hiatus or the foramen of Morgagni.

Infants with large defects of the diaphragm do not, as a rule, survive for many hours, but Hedblom<sup>4</sup> mentions two cases in which the patient reached adult age with congenital absence of half of the diaphragm. Kleine<sup>5</sup> last year reported what he believes is the most extensive congenital diaphragmatic hernia thus far recorded. The stomach, duodenum, entire small intestine, ascending, transverse, and part of the descending colon, the pancreas, spleen, and upper pole of the left kidney, and the left suprarenal gland were all in the left pleural cavity. The opening in the diaphragm extended from the oesophageal hiatus to the left wall of the abdomen, but it was not in connection with the natural apertures for the passage of the oesophagus, vena cava and aorta. From right to left it measured 4.7 centimetres, the sagittal diameter was 3.3 centimetres. The sigmoid colon was constricted in the shape of an hour-glass where it passed through the diaphragm, but the lumen was not closed; it contained meconium. The child was born after a normal labor and was not otherwise malformed. Immediately after birth it breathed and cried, but respiration soon became superficial and irregular and after four hours respiration ceased.

Kleine does not believe that the hernial opening in this case was due to defective development of the diaphragm, but holds that an exaggerated ascension energy of the left kidney was the responsible factor. Normally, the kidney reaches its final position under the diaphragm in the fifth to the sixth week of embryonic life. The pleuro-peritoneal foramen does not close before the eighth or ninth week. If the impulse that causes the ascent of the kidney should be abnormally strong, that organ could, therefore, push up beyond the diaphragmatic level at this point and prevent closure of the temporary physiologic aperture. Later this opening could become enlarged and admit other abdominal organs. This is the theory advanced by von Mikulicz-Radecki<sup>6</sup> to explain a case of right-sided renal dystopia with true diaphragmatic hernia. Gruber<sup>7</sup> and Liepmann<sup>8</sup> published similar cases but did not suggest this etiology. A fact which Kleine believes supports this theory of origin for his case is that the kidney was firmly affixed to its bed, whereas the other herniated organs were free. The extreme grade of the hernia is accounted for by the persistence of the common mesentery.

Hernia, congenital or traumatic, is much more frequent through the left half of the diaphragm than through the right, which, in addition to being, it appears, stronger, is protected by the presence of the liver. The greater interest, therefore, attaches to Jansen's<sup>9</sup> case, in which almost the entire right leaf was absent. A diagnosis of diaphragmatic hernia was made by means of the röntgen ray and a small amount of ingested barium on the sixth day of life. The child lived three weeks. At autopsy the entire small intestine and part of the large intestine were in the right thorax.

Schwartz<sup>10</sup> reports a case of congenital absence of all that part of the diaphragm that takes its origin from the quadratus lumborum and the left pillar. Since there was a hernial sac formed apparently of apposed pleura and peritoneum, the anomaly dated from the fetal rather than the embryonic period. The œsophagus passed into the opening and was found, together with the right pneumogastric nerve, in the wall of the sac. This hernia did not reveal itself for forty-seven years.

A slightly different cause for congenital hernia is congenital enlargement of one of the natural permanent openings in the diaphragm. Of these, the opening for the passage of the œsophagus is the one that most often gives rise to the condition. Barsony<sup>11</sup> thinks that these hernias are not uncommon, but adds that their clinical importance is uncertain. They may be caused by a congenitally short œsophagus; in this case, a portion of the stomach, beginning with the cardia, will be above the diaphragm and reposition is impossible. The opaque substance runs promptly into the subdiaphragmatic portion of the stomach and, with the patient standing, röntgen examination may yield no evidence of hernia; with the patient in the prone position, the herniated portion of the stomach may simulate dilatation or diverticulum of the œsophagus. In other cases, the œsophagus, though of normal length, has not entered the abdomen, and the hernia is situated beside or behind it. Or, again, the œsophagus is not fixed beneath the diaphragm and ascends, taking the stomach with it through an enlarged hiatus. Schilling<sup>12</sup> shows röntgen pictures in a case in which the entire stomach, together with the first part of the duodenum, had ascended through the œsophageal hiatus. The patient was a man of fifty-eight with no history of trauma. Symptoms, chiefly pain over the sternum, appeared first at the age of twenty-seven. At no time were there symptoms from the side of the lungs or heart.

Failure of the œsophagus to attain its adult length, on account of cicatrices resulting from the swallowing of a corrosive substance at the age of twelve years, which necessitated treatment with bougies over a period of many years, is offered by Samuelsen,<sup>13</sup> in explanation of an œsophageal hiatus hernia. The gastric symptoms began at the age of fifty-eight.

The œsophageal opening may become enlarged as the result of trauma. Sisk's<sup>1</sup> patient fell a distance of 14 feet, landing on head and shoulders. No special injury was noted at the time, but, soon after, the man began to have pain and a feeling of fullness in the lower part of the left chest, with attacks of nausea and occasional vomiting; lying in certain positions in bed caused distress. A year later he had a severe attack, which was diagnosed cholecystitis (an error that has been made in a number of cases of diaphragmatic hernia). It was not until five years after the fall that a diagnosis of an intermittent hernia through an enlarged œsophageal hiatus was made röntgenologically.

Most writers on this subject include diaphragmatic hernias from falls and accidents involving crushing of the trunk under traumatic hernias, but some are of the opinion that such accidents never cause a rent in a wholly

intact diaphragm and that they result in hernia only where there is an already existing congenital weakness or defect of the muscle. A number of diaphragmatic hernias have been reported following automobile accidents, where a person has been pinned under a car with compression of the lower thorax and the epigastrium, and they have been explained by rupture of the diaphragm on sudden increase of the intra-abdominal pressure.

Lafourcade<sup>11</sup> offers a different explanation for his case. The tear in the diaphragm started at the spinal column and passed in a forward and slightly lateral direction to the neighborhood of the internal surface of the ninth rib. It corresponded to the site of the juncture of the left leaf of the phrenic centre with the muscle fibres of the diaphragm. While admitting that this rent could have been caused directly by increased intra-abdominal pressure, he thinks it probable that this pressure widened the base of the chest, separating the costal insertions from the phrenic centre insertions of the muscle fibres of the diaphragm, and causing rupture of the latter at this point. The patient was a man, aged thirty-three, who, in a collision, had been struck by a part of an automobile in such a way that the epigastrium and lower part of the thorax were forcibly compressed anteroposteriorly.

Lecene's<sup>15</sup> patient, a vigorous, muscular man of twenty-five, sustained a rent in the diaphragm extending from the œsophageal orifice to the middle of the phrenic centre—about 15 centimetres—from being pinned under an overturned automobile, with compression at the "waist" level for a number of minutes. There were no rib fractures and the result seemed to be limited to shock, but when, after a week, he was given semi-solid and solid food, he vomited it all, usually at once. The taking of liquids was followed by palpitation of the heart. A month after the accident, röntgenologic examination with barium showed the stomach almost wholly in the left half of the thorax.

Sauerbruch<sup>10</sup> mentions that crushing is more likely to result in diaphragmatic hernia in young persons than in those of more advanced age, because of the elasticity of the thorax in youth, which permits of its being widened and the diaphragm, in consequence, stretched.

The most frequent causes of frankly traumatic hernia are gunshot, shell or stab wounds of the diaphragm. Since such wounds commonly involve all of the layers of the diaphragm, these hernias seldom have a sac. It is probable that the hernia (more correctly, prolapse) follows immediately on the injury in such cases, but the length of time that has in many instances elapsed between the injury and the appearance of any symptoms of consequence from the side of the hernia is certainly remarkable—ten years in Lecene's<sup>17</sup> case of shell injury of the left shoulder, axilla and flank. Breitenner,<sup>18</sup> who studied four cases of traumatic hernia with late manifestations, describes two courses which the trouble may take after recovery from the initial dyspnoea, nausea, inability to eat and general feeling of illness. In the one, after a period of months during which the patient has complained only of vague gastric pains, independent of taking food, and of occasional dyspnoea, symptoms of high intestinal obstruction appear suddenly, following some physical exertion beyond the ordinary. In the other, there are repeated attacks of vomiting and severe pain in the upper abdomen on the side of the injury, and these attacks always come on after ingestion of an unusually large amount of food. In the intervals the patient is wholly free from symptoms. In both cases, the pain is particularly severe under the costal

margin on the injured side. The pathologic basis differs for these two clinical pictures. In the first case, "incarceration" of the stomach and transverse colon in the thorax, with torsion of the stomach to 180 degrees around the sagittal axis and a slight degree of torsion around the vertical axis. In the second case, there is incarceration of a gastric-wall hernia in an opening in the diaphragm.

A cause of traumatic hernia that is, apparently, only beginning to be recognized, but that is of interest to the surgeon from a double point of view, is accidental slitting of the diaphragm during operation of the thorax. Hedblom<sup>4</sup> in a review of 378 cases found three such. In what can scarcely be described as more than a glance through the very extensive recent literature on diaphragmatic hernia, I have come upon three cases in which this etiology is given as probable or possible. Two of these cases were published since Hedblom's review.

MacMillan<sup>19</sup> relates that a soldier had empyema following lobar pneumonia in the left lower lobe. It was drained for two months, after which it healed. Three months after the pneumonia, a röntgenogram was taken to determine the condition of the lung before discharge. It showed the stomach-fluid level and the gas bubble in the left chest. Examination with barium showed an hour-glass stomach with the fundus above the diaphragm and the splenic flexure in the thoracic cavity. The patient's only complaint was slight dyspnoea. There was no history of trauma in this case, the man had not seen action. The hernia was either congenital or due to injury to the diaphragm at operation and MacMillan holds the latter origin to be the more probable.

Adamy<sup>20</sup> reports the case of a woman, aged thirty-seven, who was operated on for post-influenzal pleural empyema on the left side, with resection of the sixth rib. Because of persistent retention of secretion, counterdrainage was established in the fourth interspace anteriorly, above the left breast. A fistula formed and did not close until two and a half months after operation. About one year after the operation, the patient began to have frequent attacks of pain in the left chest, worse on deep inspiration, and radiating into the left side of the neck. There were dyspnoea and palpitation on exertion and weakness and formication in the left arm. She could sleep only on the left side. Physicians consulted laid the symptoms to adhesions and shrinking of the pleura. When the patient was examined by Adamy, these symptoms had continued undiminished for seven years and had lately become worse. Auscultation left the question open between echinococcus of the lung, residual pneumothorax with exudate, and diaphragmatic hernia. The results of percussion of the heart borders proved puzzling. The first examination showed displacement of the heart to the right by one and one-half fingerbreadths, but twelve hours later it was found much farther to the right. The patient said she often had rumbling under the operation wound, but a history of trauma was absent and there had been no severe peritoneal complications at the time of operation. Röntgen examination showed a large part of the stomach and the splenic flexure of the colon above the diaphragm. The lowest part of the stomach filled first; by palpation the contrast mixture could be pressed into the upper part. With the patient lying down, the contrast mixture filled the upper portion completely. The greater curvature was directed upward, the stomach being twisted on its axis about 180 degrees. The difference observed in the position of the heart at the two examinations was now understood as depending on the state of distention of the stomach. The paraesthesias in the left shoulder region are explained as distant phrenic nerve symptoms. This nerve has sensory endings in the peritoneal covering of the diaphragm, which anastomose with nerves supplying the neck and shoulder. Pain in the shoulder has been noted repeatedly in diaphragmatic hernia.

Since the history presents no basis for any other theory of etiology, Adamy believes that injury to the diaphragm at operation must be assumed as the cause of this hernia. He thinks it probable that the injury was confined to the diaphragmatic pleura and the muscular portion of the diaphragm, the peritoneal layer remaining intact and forming a hernial sac. Operation had not been performed at the time of the report. This case, Adamy points out, teaches the danger of exploratory puncture with unclear pulmonary findings.

The third case was published as a case record of the Massachusetts General Hospital, discussed by McAllester, Bock and Jones.<sup>21</sup> A woman had pleurisy at the age of thirty-one. The effusion was drained. She is now fifty and she says that for "over fifteen years" she has had "bilious attacks" occurring about once a month and lasting two days. The attacks usually begin at night, with nausea, vomiting, palpitation, some headache and dizziness. She has dyspnoea and palpitation on exertion and frequently she has pain under the left lower ribs. The bowels are irregular. The hæmoglobin is 60 per cent., erythrocytes 4,100,000, blood smear normal. Röntgen examination shows about half of the stomach passing into the chest through the œsophageal opening. McAllester suggests that the diaphragm may have been injured when the pleuritic effusion was drained.

Bock calls attention to the anæmia in this case and says that he has seen three cases with blood picture of severe secondary anæmia and bleeding from the gastro-intestinal tract in which diaphragmatic hernia was the only pathologic finding. In the literature on diaphragmatic hernia he has seen no mention of gastro-intestinal hæmorrhage. Sisk,<sup>1</sup> it may be pointed out, found occult blood in the stools in one of his cases.

On leaving this discussion of the various ways in which there may come about a diaphragmatic opening that can give rise to hernia, something may be said of that force which drags the abdominal viscera up through the aperture, overcoming gravity and even anatomic anchoring. This force is generated by the difference between the pressure in the thoracic cavity and that in the abdominal cavity. It is the combined influence of pressure and suction, acting with every breath that is drawn, that causes a hernia, once started, to get progressively worse and that creates a hernia out of a weak spot in the diaphragm.

The natural tendency of the organism to set its house in order even in the face of great odds is thus beautifully exemplified in the case reported by Stimson and recently cited by Truesdale,<sup>22</sup> in which a hernia of the entire stomach, demonstrated beyond question in an infant of eleven months, is no longer present in the same child at the age of eight years. Truesdale believes that with hernia of the stomach in infants the tendency is for the opening to get smaller, provided, of course, that the viscus rides freely back and forth through the aperture. Until röntgen examinations are made routinely of every newborn baby, we shall not know how frequent congenital diaphragmatic hernia really is nor shall we be able to form an idea as to whether or not a considerable percentage of such hernias undergo spontaneous cure in early childhood. However this may be, there is, in spite of the action of gravity, scarcely a single known case, as Sauerbruch<sup>16</sup> points out, in which thoracic organs have descended into the abdomen, even with wide open communication between the two cavities.

The symptomatology, referable to the respiratory and circulatory systems on the one hand, to the gastro-intestinal system on the other, varies with the location of the hernia, with the organs herniated and their condition—whether kinked, twisted or constricted—and with the degree of crowding to which the heart and lungs are subjected. Symptoms may be absent and the physical findings practically normal. The symptoms vary with the fullness of the herniated stomach and intestine, and so with the time of day. They vary with the position of the patient; the attacks are frequently mentioned as coming on at night, *i. e.*, with the patient lying down, when gravity acts to enlarge the hernia if it is mobile in the ring, and to distend with fluid a herniated portion of the digestive tube. The partially herniated stomach may alter its position so that the œsophagus that at one time empties above the diaphragm at another time empties below it.<sup>10</sup> Pain that depends on difficulty in the filling or in the emptying of the portion of stomach above the diaphragm will then appear at different times relative to the taking of food. Volvulus of the herniated stomach is fairly frequent; the mechanical conditions are right for it when the stomach wall is fixed to the hernial ring,<sup>2</sup> and when it is present it adds its own symptoms.

The röntgen examination, though beyond question our best, and often our only means of discovering the hernia, cannot always be depended on. If the hernia is intermittent, the picture may be negative. Röntgen examination may fail also if the lumen of the digestive tube is so constricted in the ring that the contrast substance cannot pass from the lower into the upper portion. The circumstances of a diaphragmatic hernia are so unpredictable that it may be extremely difficult to interpret the röntgen picture correctly. Haberer<sup>2</sup> thought he saw an eventrated left diaphragm with the stomach lying in the raised convexity. What he took to be the dome of the diaphragm turned out to be the smooth, convex greater curvature of the stomach, lying upside down above the diaphragm.

It is generally agreed that all diaphragmatic hernias should be operated on, except œsophageal hiatus hernias with short œsophagus, in which repair is impracticable and the symptoms of which may be held in check by dietary management. Also possibly some other small congenital hernias that are practically symptomless, and certain types of hernia in very young children, in which a waiting policy may seem advisable. The presence of a loop of colon in the chest greatly intensifies the desirability of operation, because of the grave hazard of intestinal obstruction.

Diaphragmatic hernia presents especial dangers in pregnancy and labor.

Schwartz<sup>10</sup> reports a case in which a hernia, the result of a revolver bullet wound, gave active symptoms only during three successive pregnancies. The first pregnancy occurred four years after the injury; four and three years separated the pregnancies. The symptoms consisted of vomiting and pain, in crises, which began, in the first two pregnancies, in the fifth month; in the third pregnancy, in the third month. The woman was spontaneously delivered of a living child in each case. In the first pregnancy she was about to be operated on for a supposed beginning peritonitis, when, on the eve of the day set for the operation, the delivery, and with it immediate cessation of symp-



toms, took place. In the next pregnancy she was operated on for supposed appendicitis. In the third pregnancy hepatic or nephritic colic was diagnosed. The intervals between the pregnancies were symptomless except for pain in the left side on effort, but a year after the birth of the third child a persistent cough developed. It was thought that she had pulmonary tuberculosis and a röntgenogram of the chest was made. The diaphragmatic hernia was then discovered. A year and a half later, again several weeks pregnant, she came to Schwartz. Röntgen examination showed an opaque mass, the size of an adult head, in the left thorax, reaching almost to the clavicle. Schwartz operated and found the hernial orifice, the size of a "five-franc piece", about 8 centimetres distant from the costal margin. The diaphragm was very thin and atrophic. The hernia contained about one metre of ileum, the cæcum and the ascending and transverse colons. There were no adhesions except a few of the omentum. The pregnancy continued, but Schwartz was contemplating interrupting it for fear that the repaired diaphragm would not be able to withstand the additional pressure.

Granzow<sup>23</sup> advises sterilization for all women in the childbearing age who have diaphragmatic hernia and who cannot or will not be operated on. In the case that he observed, an unrecognized hernia, dating in all probability about nine years back, when the woman was run over, with resultant fracture of the dorsal spine, gave no serious trouble during pregnancy (loss of appetite and progressive nausea toward the end, no vomiting). She entered the clinic in labor. On the left side of the chest neither heart nor lung sounds could be detected, but gurgling and splashing were heard. Röntgenologic examination confirmed the supposition of diaphragmatic hernia. It showed the stomach entirely filling the left half of the thorax, the heart, trachea, large vessels and œsophagus being pushed to the right. A second röntgen picture, taken four hours later, showed that the displacement of the thoracic organs had progressed; the right border of the heart was almost at the axillary line. The danger from kinking of the large vessels on greater crowding of the mediastinum from further upward pressure of the abdominal viscera, during the period of expulsion, was recognized, and it was decided to deliver the child by forceps at the end of the first stage. But before this time arrived, the mother became cyanosed. With high forceps an asphyxiated but living child was delivered. The placenta followed spontaneously, but the mother was seized suddenly with abdominal pains, vomited, and died under the picture of asphyxiation. At autopsy an aperture the size of a hand was discovered in the left half of the diaphragm and in the left pleural cavity were found the stomach, greatly dilated, the spleen, the greater part of the omentum, and the splenic flexure and adjoining parts of the transverse and descending colons.

For the approach to a diaphragmatic hernia some operators prefer laparotomy; others, thoracotomy. Others, again, open both thorax and abdomen by one incision. If intestinal obstruction complicates the situation, Truesdale<sup>24</sup> advises doing a cecostomy or appendicostomy and proceeding at a later stage to the repair of the hernia.

*Ultimate Results.*—Hedblom<sup>4</sup> found recurrences reported in about 5 per cent. of cases. In one of Truesdale's<sup>22</sup> cases there were three recurrences in the course of three years in a child five years old at the time of the first operation. He thinks that the condition of the diaphragm on one side of the line of repair, rather than the method of suture, was responsible. Few writers who report cases give late results. Leriche<sup>25</sup> and Lecene<sup>17</sup> report seven and three year cures, respectively, in cases due to war wounds. Leriche's case was a recurrence. The aperture measured 4 or 5 centimetres. He fastened the internal lip of the orifice to the wall, making a horizontal dia-

phragm; in this manner the entire defect was made to disappear. He suggests as other possible means in difficult cases; suture of the internal diaphragmatic lip to the soft parts of the thorax, cutaneous autoplasty, disinsertion of costal or posterior attachments of the diaphragm, and paralysis of the diaphragm by means of phrenectomy. In Lecene's case the opening in the diaphragm measured 6 x 4 centimetres but had to be enlarged to effect reduction. It was closed with over-and-over linen sutures.

#### REPORT OF CASES OBSERVED BY AUTHOR

CASE I.—Colored girl, age twenty-two, received a stab wound in the left chest in 1924. Seen six hours later. General condition good and no signs of shock. A large piece of the great omentum was hanging from the stab wound between the seventh and eighth ribs in the mid-axillary line. It was evident the knife had penetrated the diaphragm and the omentum had herniated through it.

*Operation.*—The abdomen was opened through an upper left rectus incision. Exploration revealed no injury to the abdominal viscera. An opening was found in the centre of the dome of the left diaphragm. It would admit two fingers. The omentum had passed through it. The contaminated omentum hanging from the chest wound was unfit for reduction. The stab wound was enlarged five inches, the ribs spread, the omentum drawn out a short distance and amputated. The clean proximal segment was then drawn back through the diaphragm into the abdominal cavity. The pleural cavity was carefully packed off and a clean wound two and one-half inches long exposed in the diaphragm. Through the thoracic wound the diaphragm was closed by using a few interrupted sutures and a continuous row of chromic catgut. Both the abdominal and thoracic wounds were closed without drainage. Convalescence uninterrupted. The lung soon re-expanded and she left the hospital three weeks post-operative in good condition. There was no infection of the pleura. Patient was seen a few months post-operative and she was all right. It has been impossible to trace her since that time, now five years ago.

CASE II.—Entered the clinic May 1, 1929. Mrs. W. S. H., white, sixty-five years of age, married, mother of four children. Past history unimportant. Normal menopause at forty-five. Successful hemorrhoidectomy ten years ago. No history of trauma.

Her trouble dates back only five years. Chief complaints were epigastric pain immediately after meals, crowding of gas up under the ribs, choking spells, and six attacks of severe epigastric colic radiating up into the chest and between the shoulders. During the height of the pain she thought her heart would stop. Hypodermics of medicine were required for ease. Belching would sometimes benefit. The attacks of pain would last about one hour or until the stomach was empty. Bothered with some pain under the shoulders between spells. She did not spit up her food. Troubled some with qualitative food dyspepsia of the usual gall-bladder type.

A cholecystogram was attempted but the gall-bladder could not be visualized. The clinical history and röntgenologic study of the biliary tract could easily be interpreted in terms of chronic cholecystitis. Ingested barium meal revealed a portion of the stomach above the diaphragm. It was interpreted as a diaphragmatic hernia of the stomach. It was not sufficiently constricted to prevent emptying of the upper loculus. The stomach was fixed (see Fig. 1).

On account of her age, sixty-five years, she was put on medical management and surgery not advised then. That was eight months ago. A letter from her last week indicates that she is getting along quite well and the spells are no worse. She was told that likely the gall-bladder should be removed and the diaphragm explored if her condition grew worse. Up to the present time she is quite content with her lot.

CASE III.—First examined December 14, 1924, T. M. B., white, male, age thirty-eight. Married fifteen years. No children. Early history unimportant. Fourteen years ago at the age of twenty-four years, he was injured in a railroad wreck. Extent of trauma not mentioned but he was considerably bruised. He got along very well until nine months ago when he was injured in a second slight "explosion" in some sort of a railroad accident. The injury was not severe. His occupation was a farmer until four years ago, since which time he has been in the transfer business. His chief complaints on entering the clinic were pains all over the body, a sluggish feeling and some gas and distress in the stomach after meals with belching, which gave relief. No severe attacks of colic.

He was a well-developed man; weight 160 pounds. Blood pressure 122/80. Pupils

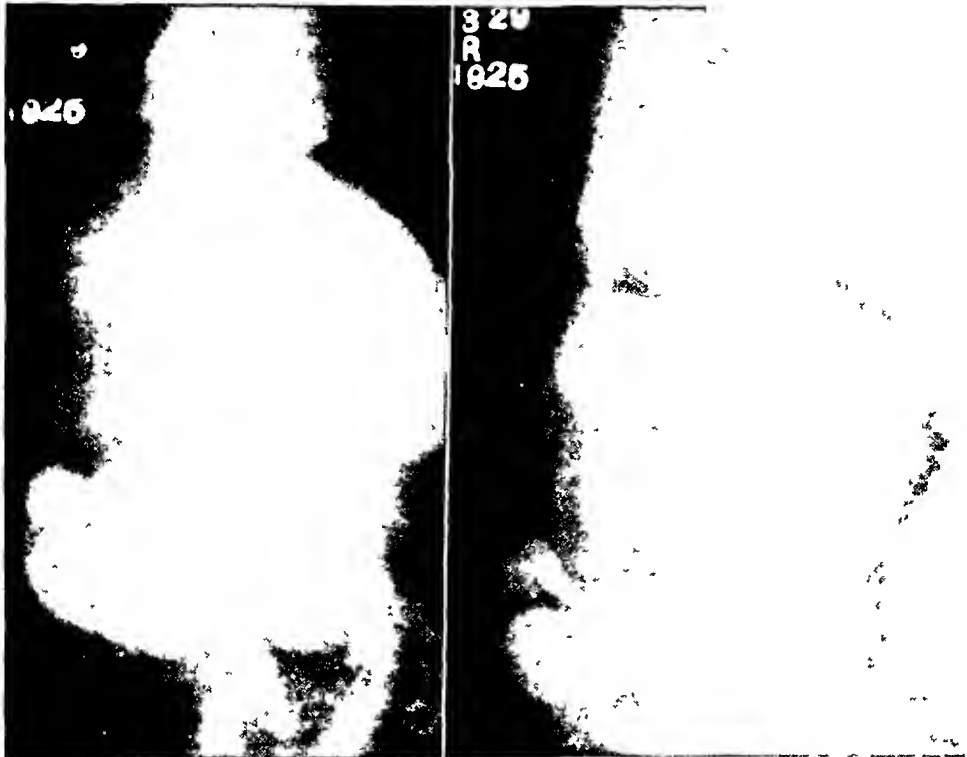


FIG. 1a.—No. 31925. Female, age sixty-five years. Large portion of stomach above the diaphragm. Note the hour-glass effect. Stomach and duodenum otherwise negative.

FIG. 1b.—Same case as shown in Fig. 1a. A few minutes later, when the constriction has lessened and the upper loculus has begun to empty. That portion above the diaphragm is fixed rather firmly.

irregular and fixed. Knee and ankle jerks about normal. Blood Wassermann negative. Spinal fluid four plus in all dilutions. Other findings essentially negative including a complete neurologic examination. Electrocardiographic tracing normal. X-ray of the chest showed the aorta 4 centimetres, right heart 6 centimetres, left heart 6 centimetres. The heart and mediastinum displaced to the right. *Ingested barium meal revealed more than half of the stomach above the diaphragm on the left.* Barium enema revealed the colon within the abdomen.

*Diagnosis.*—(1) Left diaphragmatic hernia with a large portion of the stomach in the thorax; (2) Cerebro-spinal lues.

*Treatment.*—Antileptic remedies have been used since then and he has gotten along very well now for more than five years. Stomach symptoms are unchanged. The position and fixity of the stomach not changed. Surgical treatment was not advised

## DIAPHRAGMATIC HERNIA

on account of the associated condition and the lack of severity of his symptoms. Likely trauma played an important part in the etiology of this case (See Fig. 2).

CASE IV.—First examined December 7, 1928, R. F. S., white, female child, five and one-half years of age. The patient was the first child, full term, breast fed, well developed. At 2 and one-half years of age, after a cold lasting a few days, she developed a left empyema. Thoracotomy with resection of two and one-half inches of the seventh rib in the mid-axillary line was done (elsewhere), and a drainage tube was left in several weeks. She was quite sick, emaciated, and coughed a great deal for a number of months. Much pus was raised. About one year after the operation she was seized with a violent attack of abdominal pain with associated nausea and vomiting. No bowel movement for three days. In bed one week and relieved after a large dose of castor



FIG. 2a.—No. 22060. Male, thirty-eight years. Diaphragmatic hernia showing a large portion of the stomach above the diaphragm. Note the incompletely filled lower part. (See also Fig. 2b.)



FIG. 2b.—No. 22060. Male, thirty-eight years. Same case as Fig. 2a. A short time later, when the upper portion of stomach is emptying into the lower and leaving the gas bubble above. About half of the stomach is above the diaphragm and is partially fixed.

oil. Similar attacks have occurred on an average of once a week since. Some spells were worse than others. A hypodermic of some opiate was used for ease in most of the attacks. The spells usually came on late in the afternoon or at night, and lasted several hours. The pain was usually located about the umbilicus, in the epigastrium, and radiating to the left neck. Between attacks her appetite was good and she experienced a feeling of well-being. The spells recurred without reference to diet or bowel movement. She was usually constipated. A great deal of rumbling in the bowels was noticed by the parents when the attack was at its height. The noise could be heard across the room. She preferred to sit or double over during the attack. There was no chest pain nor dyspnoea noted. She took cold easily; head cold now at time of examination.

She was a well-developed and nourished child, height 45 inches, weight 46½ pounds. Hypertrophied tonsils and adenoids, subacutely inflamed. Chronic suppurative maxillary sinusitis, bilateral. Cervical adenopathy. Urine and blood negative. The

lungs on the right side were normal; left, breath sounds clear above the old thoracotomy wound.

*X-ray of the chest.*—Seventh rib deformity still visible on the left; chest symmetrically developed; obliteration of left costo-phrenic angle. A large portion of the stomach lay above the left diaphragm; duodenal cap negative. Barium enema shows a loop of the colon above the diaphragm, the proximal portion distended. Evidently a diaphragmatic hernia, with a portion of the stomach and colon in the thorax.

The maxillary sinuses were drained and the tonsils and adenoids removed March 16, 1929. She was soon free of the upper respiratory foci of infection. On April 9, 1929, the operation was done to repair the diaphragmatic hernia.

*Operation.*—Ethylene anæsthesia was given through a positive pressure machine. An upper left rectus incision four inches long was made through which the diaphragm



FIG. 3.—No. 30979. Female, age five and one-half years. Barium enema. Loop of transverse colon visualized above diaphragm. Dilatation of proximal segment. Operation with reduction of omentum, colon and stomach into abdomen. Recovery.

FIG. 4.—No. 30979. Female, age five and one-half years. Same case as shown in Fig. 3. Shows child four weeks post-operative. Uneventful recovery. Note the scars of the combined abdominal and thoracic approach.

was explored. An opening  $2\frac{1}{2}$  inches in diameter was found in the left diaphragm a little posterior to the dome. Transverse colon and a portion of the stomach were densely adherent in the opening and could not be withdrawn into the abdomen. An incision was then made over the eighth rib in the mid axillary line extending well forward. A portion of the rib was resected. The former empyema operation had left pleural adhesions which permitted the lung to be pushed well out of the way without opening into the clean pleural cavity. The entire great omentum, a small portion of the fundus of the stomach, and a long loop (8 inches) of the transverse colon nearest the splenic flexure were firmly adherent high in the chest. With one hand in the abdomen, the diaphragm was pushed well into the thoracic wound where the neck of the sac was exposed, and the tissues freed from it all the way around. It was necessary to widen the opening in the diaphragm nearly two inches in order to reduce the hernia into the abdomen. The structures were then easily pulled down by the hand that

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was in the abdomen. The edges of the diaphragmatic opening were freshened, and it was closed by using mattress sutures of chromic catgut and a second row of continuous sutures making the approximation smooth and even. All suturing was done through the thoracic wound. There was a false sac of constricting material still about the loop of the transverse colon. It was carefully cut away and the colon straightened out. Both wounds were closed without drainage. The operation was easily and satisfactorily completed and the patient was returned to her bed in good condition. It was a "false" or acquired hernia without a true sac.

The post-operative convalescence was satisfactory. The abdominal wound healed primarily. A small amount of serum accumulated in the thoracic wound but there was no infection. She was entirely well in four weeks. Bowels moved spontaneously and she has never had a cramp since.

May 4, 1929, approximately four weeks post-operative, an X-ray of the chest was made: Left diaphragm high and costo-phrenic angle obliterated; left lung expanded but the lower lobe is still somewhat compressed; no fluid. The entire stomach and colon were below the diaphragm.

She was dismissed from the hospital May 25, 1929, as completely well. A letter from her mother, seven and one-half months post-operative, reports the child in perfect physical condition and still entirely free from cramps. Her bowels move regularly and she is a regular attendant at school. She is now forty-nine inches tall and weighs fifty-three and one-half pounds.

### COMMENT

Diaphragmatic hernia is apparently a more frequent condition than we have previously thought it to be. Many cases are probably never diagnosed because they are not producing symptoms sufficient to urge the person into a complete examination including a röntgenologic study of the gastro-intestinal tract. The combined abdominal and thoracic approach probably expedites the operation and makes it easier and safer for the patient. I have been able to find but few cases recorded in the literature where a previous empyema was the probable cause of a weakened diaphragm eventuating in a hernia. In all probability, my last case here reported is a sequel to such an operation and should be so classified.

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# DIAPHRAGMATIC HERNIA

## PHRENIC NERVE STIMULATION UNDER FLUOROSCOPE AS AN AID IN DIAGNOSIS \*

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THE purpose of this paper concerns itself with the differential diagnosis between diaphragmatic eventration and hernia, with some remarks about the technical procedures in the treatment of the latter condition.

For a long time, diaphragmatic hernia has been a much-discussed abnormality. Curiosity was first aroused by Ambroise Paré<sup>1</sup> in 1610. From then

on, occasional cases were observed during the course of post-mortem examinations and were quite fully described by Cooper<sup>2</sup> in his treatise on hernia in 1844. Bowditch<sup>3</sup> assembled eighty-eight case reports in 1883. With the introduction of the röntgenogram, the recognition of diaphragmatic hernia during life has added materially to the knowledge accumulated in regard to the various phases of this subject. Embryologic, anatomic and pathologic considerations



FIG. 1.—Anterior-posterior röntgenogram made before operation. Note thin arched shadow in left lower thorax due to diaphragmatic hernia. During quiet breathing this was stationary and showed only a slight paradoxical movement during forced breathing.

have been thoroughly treated by Sailer and Rheim,<sup>4</sup> Keith,<sup>5</sup> and Richards.<sup>6</sup> Analysis of various case reports has been made by Struppler,<sup>7</sup> Griffin,<sup>8</sup> Seibert,<sup>9</sup> Hedblom,<sup>10</sup> and others.

Probably the first case recognized clinically and subsequently operated upon was that reported by Naumann<sup>11</sup> in 1888. A year later, Walker<sup>12</sup> reported a successful operation for a diaphragmatic hernia of traumatic origin. Scudder,<sup>13</sup> in 1912, collected from the literature, fifty-three cases which had been treated surgically. Röntgenologic aspects of this subject have

\* Read before the Philadelphia Academy of Surgery, December 2, 1929.



been taken up by LeWald,<sup>14</sup> Uspensky,<sup>15</sup> Carmen and Fineman,<sup>16</sup> and Pancoast and Boles.<sup>17</sup>

All writers have considered diaphragmatic hernia as a condition in which there is a defect in the diaphragm through which abdominal viscera protrude. The defects may be congenital or acquired. They may occur in various parts of the diaphragm, through normal openings, through weak portions due to the lack of development of the musculature or to failure of fusion. If the defect is complete the hernia will not be covered by a sac, and the pleural and abdominal cavities will be in communication unless the opening is sealed by adhesions surrounding the herniating viscus.

Should the protrusion through the diaphragm be a large one, the dome

of the hernia may roentgenoscopically give the same appearance as that seen when the diaphragm itself has assumed an abnormally high position. To this condition the term eventration has been most universally applied, although some writers insist that better terms would be diaphragmatic insufficiency, elevation, relaxation "hockstand," etc. The thinning of the diaphragmatic partition is explained on the basis of a degeneration, or congenitally defective musculature, or a paralysis of the phrenic nerve. The



FIG. 2.—Lateral roentgenogram, made before operation, showing large diaphragmatic hernia. Note absence of irregularities in the shadow produced by protruding viscus.

difference in pressure relationships between the thoracic and abdominal cavities forces the diaphragm and viscera below it into a higher position within the thorax. In eventration the thin diaphragmatic partition forms, on the roentgenogram, a thin line separating the pulmonary tissue from air collections in the stomach or colon. In hernias the partition is formed by the sac or, if the sac is absent, by the wall of the herniating viscus.

Eventration has been confused with diaphragmatic hernia repeatedly. In fact, Petit,<sup>18</sup> who first described from autopsy findings what was undoubtedly an eventration, applied to it the term hernia, and it was left to Cruveilhier<sup>19</sup> in 1849 to make the distinction. Jaffin and Honeij,<sup>20</sup> in reviewing Bowditch's case, say that he was in error in describing it as a diaphragmatic hernia. Reifenshtein,<sup>21</sup> Menville,<sup>22</sup> LeWald, Pancoast and Boles, and other

writers on either subject, emphasize the possibility of confusion and the difficulty in diagnosis. Korns,<sup>23</sup> in concluding a critical analysis of the literature, says, "One finds himself unable to make a definite statement as to the number of genuine cases of eventration which have been studied. The criteria by which the diagnosis has been determined are extremely vague and uncertain in a great many cases."

The importance of differentiating diaphragmatic hernia from eventration is, of course, obvious from the standpoint of treatment. In hernia, gastro-intestinal symptoms of a severe character may be present, and always the potential danger of obstruction is great. Replacement of the herniating viscus and repair of the defect should be attempted. On the other hand,

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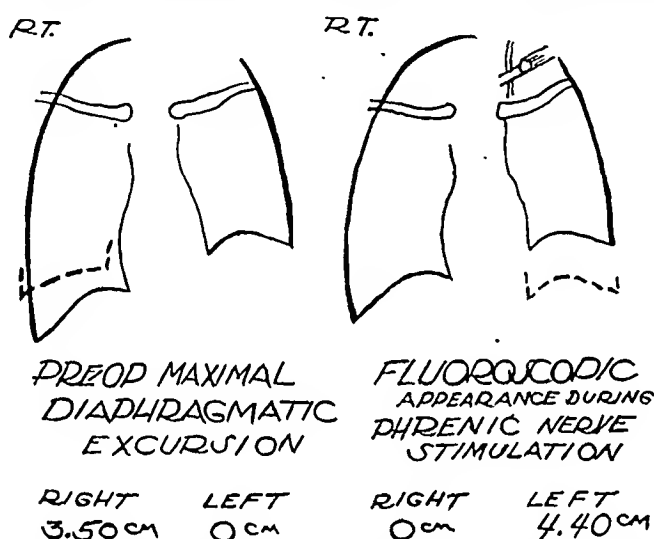


FIG. 3.—Diagrams illustrating diaphragmatic activity before and after left phrenic-nerve stimulation. During forced inspiration the right diaphragm descended 3.5 centimetres, while the left showed no variation in position. Stimulation of the left phrenic nerve caused a 4.4 centimetre contraction.

operation is rarely indicated in eventration, and the propriety of attempting surgical treatment has been doubted by most writers. Lerche,<sup>24</sup> however, planned and carried out an operation for eventration. He plicated the diaphragm with a satisfactory result.

In the differential diagnosis of these conditions a great many of the symptoms and signs are of little value. Etiologically either may be of congenital or acquired origin. The development of symptoms may arise at any time. Pulmonary and gastro-intestinal symptoms are bizarre in both and depend upon the extent of the diaphragmatic disorder and the degree of misplacement of the viscera. As a rule the gastro-intestinal symptoms are less marked in eventration, and intestinal obstruction is rare. Upon physical signs one cannot make a positive diagnosis of either condition. With air in a highly placed stomach or colon so situated because of either a relaxation of the diaphragm or a herniation through it, the high area of tympani and the altered pulmonary signs are confusing in both conditions.

For the exact differential diagnosis between diaphragmatic hernia and eventration the following methods have been applied:

1. *Movements of the Costal Margins.*—Korns has emphasized the value of the observations of Hoover regarding the relation of diaphragmatic activity to the movements of the costal arches. Normally the diaphragm antagonizes the intercostal muscles, so that during inspiration the pull of the diaphragm limits the outward excursion of the costal margin. The higher the diaphragmatic dome or the higher the plane of its activity, the less mechanical advantage it entertains. Korns pointed out that in cases of hernia the costal movements are equal on the two sides because the position of the diaphragm is still unchanged. In eventration the elevated position and faulty antagon-

ism of the diaphragm permit a more noticeable outward excursion of the costal arch on the affected side. It has been pointed out by some that in cases of hernia in which there has been a wide separation of the diaphragmatic musculature, this test may not be reliable.

2. *Röntgenoscopic Signs.*—In eventration, the diaphragm produces a thin, smoothly curved shadow which is highly placed in the lower thorax.

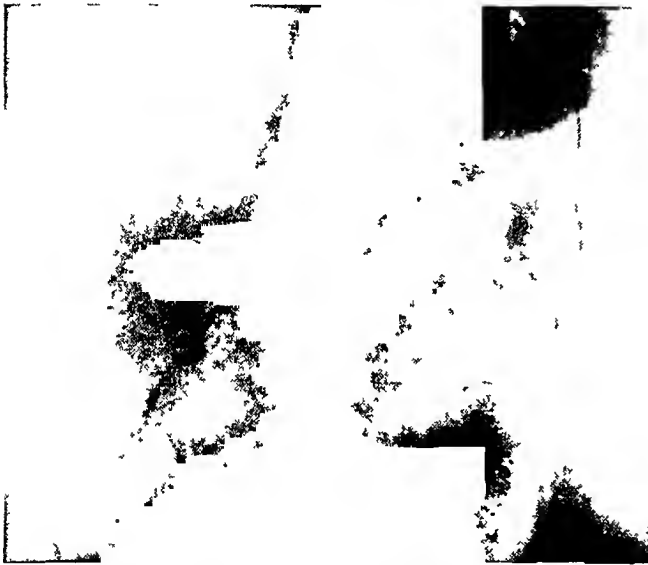


FIG. 4.—Röntgenogram made after administration of barium meal. Note position of stomach is entirely above cardiac orifice.

In hernia, this thin, curved shadow (produced by the wall of the viscus or hernial sac) may be irregular in outline. However, if the hernia is large the arching shadow on the röntgenogram may fill the entire hemithorax, and any portion of the diaphragm itself is obscured.

Some observers call attention to the absence of lung-markings behind the elevated diaphragm in cases of eventration. This has been explained by the failure in development of the pulmonary lobes on the affected side. Rheinhold has considered the condition primarily a hypoplasia of the lung, with subsequent faulty development of the diaphragm. This etiological explanation has not been accepted for the majority of the cases reported, and in Lerche's case the bronchi could be seen distinctly beneath the dome of the diaphragm.

Paradoxical diaphragmatic movements may or may not be present in either condition. This also applies to shifts in the mediastinum during the phases of respiration. These mechanisms, compensating for the shifts in the

intrathoracic negative pressure on the affected side, are dependent upon so many factors that Reifenstein, Griffin and others have reported different observations.

The administration of a barium meal, with the patient under fluoroscopic observation, is by far the most important of all of the röntgenologic procedures, according to Pancoast and Boles, and Abbott.<sup>25</sup> Carmen and Fineman point out that in hernia the opaque solution will assume a level higher than the cardiac orifice, while in eventration it will never go above that point. From Stein's<sup>26</sup> reproductions, it can be seen that this test is not reliable. Also it may be impossible to visualize that part of the stomach or colon which has assumed a false situation, regardless of the position of the patient.

Repeating the röntgenographic examination one or more times will often show, in cases of hernia, an altered picture, whereas in repeated examinations of a patient with an eventration the findings will be uniform.

3. *Intragastric Pressure Studies.*—A method of studying the pressure variations within the stomach, as described by Schliffe,<sup>27</sup> was used successfully by Hildebrand and Hess in establishing a diagnosis in the famous

Schneider case. This patient traveled about the clinics of Europe for twelve years before a condition of eventration was diagnosed. In intrathoracic positions of the stomach or in diaphragmatic hernia cases the pressure within that portion of the stomach which is within the chest varies in accordance with pressure variations within the intrapleural space. But if the stomach is still in the abdominal cavity, as in cases of eventration, the findings should be normal, *i.e.*, the intragastric curve rises with the descent of the diaphragm and falls with its ascent.

4. *Pneumoperitoneum.*—This procedure has been used by Verbrycke<sup>28</sup> and others. Lord<sup>29</sup> maintains that it is dangerous, because, if a hernia

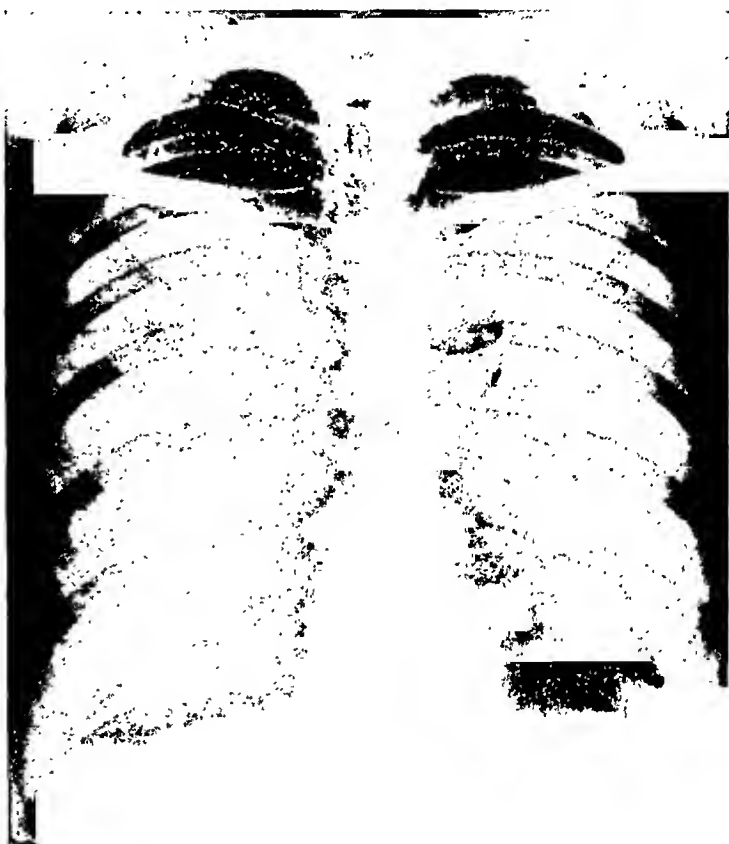


FIG. 5.—Anterior-posterior röntgenogram taken four months after operation for repair of diaphragmatic hernia. The irregular portion of the diaphragmatic shadow is due to an early recurrence of the diaphragmatic hernia. Note elevated position of the diaphragm due to temporary paralysis produced by phrenic nerve crushing. Fluoroscopically the left diaphragm showed no activity.

without a sac is present, a pneumothorax would result. With our present knowledge of the effects of pneumothorax it would seem that the danger of this procedure has been overestimated.

5. *Laparotomy.*—There are reports of the necessity of resorting to an operation in order definitely to establish a diagnosis. In fact, Lord recommends laparotomy in preference to pneumoperitoneum, a position which hardly seems justifiable.

6. *Faradization of the Phrenic Nerve.*—In the English literature, no record can be found of the use of this method to establish a *positive* diagnosis. Eloesser, in discussing Lord's paper, raised the question as to its

practicability. Reifenstein also refers to this method of differentiating diaphragmatic hernia from eventration, but dismisses the subject by saying, "It is difficult to excite in the living individual the phrenic nerve without influencing other viscera." Korn's also minimizes the value of such a test by inferring that stimulation of the phrenic nerve cannot be done without influencing other nerves in the neck, scalenus anticus muscle, and other structures. However, Jamin<sup>30</sup> has reported the use of such a method in differentiating eventration from hernia.



FIG. 6.—Anterior-posterior roentgenogram made eight months after operation for repair of diaphragmatic hernia. Note that the recurrent hernia has greatly increased in size. The effect of the phrenic-nerve crushing had now disappeared, as the hernial sac descended 1 centimetre on deep inspiration, and the faintly visible edges of the separated diaphragmatic muscle moved 2.1 centimetres.

By exciting the phrenic nerve on the affected side, a response of the diaphragm can be seen under the fluoroscope. In eventration, the Faradization of the nerve fails to cause a contraction. In our case of hernia, the previously immobile diaphragm contracted violently during phrenic-nerve stimulation (see Fig. 3). In Jamin's case of eventration the diaphragm normally had an excursion of five millimetres, and nerve excitation showed no response.

It can be argued that the test would not apply in cases of paralysis of the diaphragm due to a central lesion. This test, however, would never be applied before there was muscle degeneration in the diaphragm, as atrophy would necessarily have to occur before eventration would be present. Andrei,<sup>31</sup> has shown that the atrophic changes following phrenic paralysis

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require three to four months and reach their maximum in five months. It has been the observation of Pendergrass,<sup>32</sup> in our röntgenologic department, that in periodic examinations of patients with phrenic-nerve paralysis, eventration is not fully developed until several months after the loss of activity was first noticed.

The study of a patient recently under our observation illustrates well the practicability of phrenic-nerve stimulation, with the patient under the fluoroscope, as a method to differentiate, definitely, between hernia or eventration of the diaphragm.

CASE REPORT.—F. P., aged twenty-two years, female. Admitted to medical service, University Hospital, March 3, 1929. There had been no symptoms until five months previously, when epigastric pain appeared. It radiated to the left and back, was precipitated by the taking of food, and was relieved by the eructation of gas. Recently there had been vomiting of food, poorly mixed with gastric juice. Patient lost twenty

### DIAPHRAGMATIC HERNIA TRACINGS FROM LATERAL ROENTGENOGRAMS

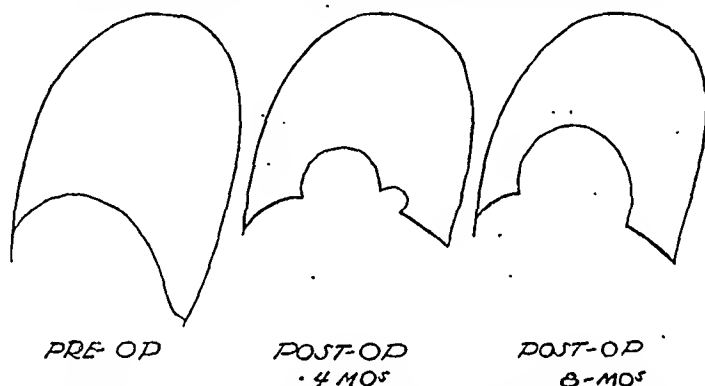


FIG. 7.—Tracings from lateral röntgenograms made before, four months and eight months after diaphragmatic herniorrhaphy. Note that before operation the herniation was of such magnitude that the diaphragmatic line was obscured. In the anterior-posterior films very little difference between the pre-operative and the post-operative examinations made eight months later can be seen. Notice that in the lateral views the contour of the diaphragm is better visualized.

pounds in weight. There were no other symptoms. The past medical history was negative except for pneumonia followed by a protracted typhoid fever four years previously. The patient had been married two years and given birth to a normal child seven months before admission.

Physical examination was essentially negative except for an area of gastric tympani which extended to the fourth rib in the mid-axillary line and was less marked when the patient was in the erect position. Expansion of the costal arches was equal on the two sides during forced respiration. All laboratory tests, including chemistry and serology, were negative. Fluoroscopically, a thin immobile partition could be seen separating the left chest from the abdomen (see Figs. 1 and 2). During quieter breathing there was no motion on the left dome, and only a slight paradoxical action upon deep breathing. The diagnosis by the röntgenologist was eventration of the diaphragm. After the administration of a barium meal, the entire stomach was found highly placed, with little deformity of its walls (see Fig. 4).

The case was reviewed by another röntgenologist who reported the presence of a large diaphragmatic hernia.

The patient was transferred to the service of Dr. George P. Muller. On March 23 the left phrenic nerve was exposed under local anæsthesia. Under the fluoroscope the

nerve was then stimulated with a minimal threshold Faradic current. The dome descended 4.4 centimetres with each excitation. The nerve was then crushed between hæmostats for a distance of three centimetres. March 26, the abdomen was opened under spinal anæsthesia. A transverse incision in the left upper abdomen was used. Relaxation of the abdominal wall and left diaphragm was well marked. An oval defect was found in the left diaphragm. It was bounded posteriorly by the crura and measured 8 centimetres in length. Through this opening a greater portion of the stomach and great omentum had herniated. These were replaced in the abdomen and the defect closed with two layers of chromic catgut mattress sutures. The patient's convalescence was uneventful throughout. The complete left-sided pneumothorax which was present after operation gradually disappeared, as did also a small pleural effusion.

July 19, 1929, the patient was seen in the follow-up clinic. There were no symptoms. By fluoroscopic examination the diaphragm was elevated and showed no motility. A small recurrent hernia could be noted (see Figs. 5 and 7).

November 15, 1929, a second röntgenoscopic examination was made. The hernia had increased in size and showed 1 centimetre excursion upon deep inspiration, while the edge of the diaphragm beneath the sacculation descended 2.1 centimetres. At this time the patient was still symptom-free and had gained twenty pounds in weight.

*Comment.*—From the study of this case the following points seem to warrant emphasis.

1. Stimulation of the left phrenic nerve under fluoroscopic visualization of the diaphragm provided an exact method to differentiate a doubtful case of a large diaphragmatic hernia from eventration. Röntgenologists had disagreed upon the diagnosis. There appeared in the röntgenoscope a thin, perfectly arched shadow, highly placed on the left side. It was immobile during quiet breathing and showed a slight paradoxical fluctuation during forced breathing. A barium meal was inconclusive, as were the symptoms and physical signs. Stimulation of the nerve supplying the affected diaphragm produced a marked contraction (see Fig. 1). By such a test the integrity of the diaphragmatic musculature was established.

2. Following the tests with the electrode, carried out as an aid in diagnosis, a temporary paralysis of the diaphragm was produced in this case by crushing the phrenic nerve. As soon as it became evident that the case was one of diaphragmatic hernia, this preliminary procedure to the operative repair of the hernia was performed. When the abdomen was opened a few days later the diaphragm was placid, could be easily mobilized for repair, and minimized many of the technical difficulties peculiar to operations upon the diaphragm. Bakes,<sup>33</sup> in 1921, recommended this procedure as a useful form of treatment in patients who could not risk radical operation, as well as a preliminary step to the surgical repair of such conditions. Harrington<sup>34</sup> has also found the method of distinct value.

3. Spinal anæsthesia, in this case, provided good relaxation, an increased tonus of the abdominal viscera, and, hence, more room in the upper abdomen, and a quiet respiration. By the combination of a preliminary diaphragmatic paralysis and spinal anæsthesia, most of the objections to the abdominal approach were therefore overcome.

4. In the first follow-up examination, at the end of four months, a small

recurring hernia could be seen to be forming in the diaphragm that was still functionless because of the preliminary phrenic-nerve crushing. At the end of eight months the activity of the diaphragm was restored, but the hernia had greatly increased in size (see Figs. 5, 6 and 7). This occurrence would seem to indicate that, once a hernia has started to form, the more active the diaphragm, the greater tendency for the herniation to increase in size. The pressure of contracting musculature at the neck of the sac would increase the tendency for impaired function or strangulation of the contained viscus. It is upon this ground that there is a basis for permanent phrenic paralysis in cases of diaphragmatic hernia in whom the operation for the radical repair is contraindicated.

From the experiences in this case it is impossible to say whether permanent paralysis should be induced as a preliminary step in diaphragmatic herniorrhaphy, or if a shorter temporary interruption in function should be carried out by merely freezing the nerve. If the former procedure be carried out, one would convert a case of diaphragmatic hernia, with possibilities of recurrence and intestinal obstruction, to one of eventration. Truesdale,<sup>35</sup> in discussing recurrent diaphragmatic hernia, does not refer to induced preliminary phrenic-nerve paralysis. He concludes, however, that a deficiency in the musculature of the diaphragm exists as a natural sequence of prolonged limitation of function or of trauma to terminal branches of the phrenic nerve in the diaphragm itself. It is quite probable that recurrences are due more to deficiencies in the tissues being sutured than in the suture material itself or in the manner in which they are placed. The technical aspects of the treatment of diaphragmatic hernia have been discussed by Truesdale, Bevan,<sup>36</sup> Soresi,<sup>37</sup> Mayo<sup>38</sup> and others.

5. Emphasis should be placed upon the value of lateral röntgenograms in the study of diaphragmatic lesions. In this case the lateral view shows clearly the sacculation of the hernia, whereas in the anterior posterior view the diaphragm is obscured (see fig. 7). In a recent study of pulmonary ventilation in post-operative patients, Muller, Overholt and Pendergrass<sup>39</sup> found that diaphragmatic studies were only of value when lateral röntgenoscopic or röntgenographic studies were made.

#### SUMMARY

Phrenic-nerve stimulation, with fluoroscopic visualization of the diaphragm, aided materially in differentiating a large hernia from possible eventration. Preliminary phrenic-nerve paralysis and spinal anæsthesia simplified the radical operation for repair of the hernia.

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# ACUTE PANCREATITIS

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WHILE acute pancreatitis represents but a small number of the acute abdominal surgical emergencies admitted to the wards of the Mt. Sinai Hospital, New York City, it constitutes a definite proportion of those arising within the confines of the upper abdomen. It is a severe abdominal catastrophe, and one attended with a grave prognosis. It seems strange with the strides which general surgery has made within recent years that the mortality of acute pancreatitis should still be so high. The factors which are instrumental in producing this mortality have been fairly well recognized, but the present method of treatment is far from standardized and it is questionable whether it is either proper or adequate. It is only by a frank clinical discussion of this condition that some light may be shed upon this rather complex, intricate and obscure problem, and with this point in view, a series of fifty-four cases of acute pancreatitis were analyzed. This comprises fifty-one consecutive cases of acute pancreatitis and three secondary to operative interference.

A review of the literature of this condition is unnecessary, for this has been recently covered by Schmieden and Sebening<sup>1</sup> in a very excellent and comprehensive paper.

The etiological factors which cause this disease are still controversial and the methods of infection and portals of entry are open to debate. Innumerable researches have stressed either one or another mechanism, and, when all are considered, it is more than likely that each avenue of infection may be responsible for individual cases.

Theoretically, infection may take place through the ducts, via the common bile duct, the duct of Wirsung, or the duct of Santorini (abetted by direct infection from the duodenum); by way of the lymphatics; through the vascular system by embolism or thrombosis; by contact with suppuration in adjacent viscera; and, lastly, by direct or indirect trauma. Certainly any survey of cases emphasizes the ductal, the vascular and the traumatic etiology. But, pathologically, the œdema, hæmorrhage and pancreatic necrosis present at the time of operation or autopsy often obscure that which may have been the responsible etiological factor in the incipient stage of the disease.

The rôle of pancreatic and bile duct variations as responsible factors has elicited considerable comment and they certainly must play an important part in the production of innumerable cases of pancreatitis. There can be no doubt that in many instances the acute inflammatory changes are due

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to those variations which favor pancreatic retention and the retrojection of infected bile into pancreatic tissue. Opie<sup>2</sup> was the first to describe an autopsy of acute pancreatitis in which a small stone lodged in the papilla caused a retrojection of infected bile into the pancreatic duct. This mechanism has been questioned by Mann and Giordano<sup>3</sup> who after a series of careful dissections concluded that the anatomical possibilities of such a mechanism were present in only 3.5 per cent. of their autopsy findings. They concluded that the number of instances is very small in which the anatomic arrangement of the two ducts would permit the passage of bile into the pancreas. Besides, in man the sphincter is located at such a point that when it does contract, both ducts are closed and not converted into a continuous channel. However, in a few cases, a small bundle of muscle fibres is found so located that when contraction takes place both ducts are converted into a continuous channel. While Mann and Giordano admit that experimental investigation has proved an anatomic and physiologic basis for the theory of pancreatic reflux, they believe that the physiologic possibility of infiltrating a pancreas with bile to cause acute pancreatitis must be exceedingly rare. In addition, any mechanism affording the passage of bile into the pancreatic duct will also obstruct the flow of pancreatic juice. Therefore, because of these reasons, the causation for most cases of pancreatitis must be sought elsewhere. Other investigators, however, were able to force bile into the pancreas experimentally by closing the papilla in from 20 per cent. to 66 per cent. of their cases.

No one can deny that gall-bladder disease bears an important relationship to acute pancreatitis. In this series about 85 per cent. of the patients presented pathological evidence of cholecystitis or cholelithiasis. In the fifty-one cases in which the pancreatitis was primary, (not secondary to operative and mechanical trauma) gall-bladder disease was present in forty-one of the forty-two cases in which the gall-bladder was described at the time of operation, and present in three of four autopsies on five unoperated cases. The gall-bladder at operation contained stones in twenty-eight, was enlarged in nine, shrunken and thickened in four, and in only three instances was it definitely described as normal, although two of these cases subsequently discharged stones through a cholecystostomy. On the other hand, in the ten-year period from 1917 to 1926 in which 1280<sup>4</sup> patients were operated for gall-bladder disease, only thirty-four presented evidence of acute pancreatitis, about 2.66 per cent. This percentage falls well within the conservative 3.5 per cent. of the anatomic possibility of duct arrangement permitting biliary-retrojection. In eight autopsies in which the finer anatomy of the ducts was given, six probably presented the variations possible for biliary retrojection. While Schmieden was able to demonstrate calculi at the papilla of Vater in seven of thirty-one cases of acute pancreatitis complicated by stone, in this series a papillary calculus was only encountered in one case although the common duct was dilated in seven instances. But the ampulla of Vater may be occluded either reflexly, or by the œdema and spasm in some cases incident

to the passage of a stone, and in others by inflammatory pancreatic enlargement. No better evidence of papillary spasm or œdema converting the bile and pancreatic ducts into one channel can be found than the occasional case of choledochal drainage attended by pancreatic reflux with the absence of duodenal contents.

Two cases in this series, as demonstrated by autopsy, were undoubtedly due to direct infection from the duodenum or the retrojection of the succus entericus, one via the duct of Wirsung opening separately and directly into the duodenum, and one by the way of Santorini. In the latter instance, the duct of Wirsung was found to be obliterated and the duct of Santorini opened directly into the duodenum.

The lymphatic origin of pancreatitis while defended by some<sup>5, 6</sup> has never been satisfactorily proven experimentally, and certainly the weight of anatomical, experimental<sup>7, 8</sup> and clinical evidence speaks against it. If lymphatic drainage is responsible for cases of acute pancreatitis, why is no instance of it recorded in our two hundred and thirty-five cases of acute gall-bladder disease, and why was it such a rare complication in 1045 cases of chronic cholecystitis and cholelithiasis?

There are a few cases in this series in which the disease occurred in localized areas of the gland. A few of these may have been due to either embolism or thrombosis engrafted on an arteriosclerotic basis.

Operative trauma is not an unusual cause for acute pancreatitis. It has been known to follow operations upon the stomach, duodenum and the gall-bladder. In two cases of subtotal gastrectomy, the injury was due to operative damage to the pancreas in dissecting an adherent perforating duodenal ulcer from the gland in one, and to infection of the tail of the pancreas by a contiguous secondary intraperitoneal abscess. In one case the pancreatitis followed a cholecystectomy with drainage, but the exact mechanism in this case was not discoverable.

The clinical picture of acute pancreatitis was often quite bizarre and the diagnosis was rarely made before operation by most surgeons because the greater frequency of other acute upper abdominal conditions invariably dominated the mind. The fact that most surgeons and clinics have their own individual pathognomonic symptoms and signs by which the condition is suspected proved quite conclusively that the symptomatology is extremely variable. Each case must, therefore, be judged on its own merits. A clinical analysis of the fifty-one primary cases in this series disclosed thirty-three of these sufferers were females and seventeen males. The fourth decade seemed to be the one in which the disease was most prevalent although it occurred in a patient as young as twenty-three and one as old as sixty-nine. The past history of these cases is extremely interesting. A symptomatology of gall-bladder disease was recited by almost half. The typical attacks of right upper abdominal pain occasionally radiating to the shoulder, often accompanied by nausea and vomiting and less frequently by signs of acute infection as manifested by chills and fever were not unusual. Occasionally the history was

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that of an ulcer and in fact a few were given medical treatment for this condition.

While 50 per cent. gave a past history of abdominal symptoms varying from weeks to years, the remainder stated their present attack was the first intimation of the disease. The duration of the present complaint varied from a few hours to several days.

The pain in acute pancreatitis was intense and oftentimes so severe as not to be relieved by morphine. In twenty-two patients it was described as originating in the right upper quadrant, radiating to the back in three; and to the umbilicus in one; in eighteen the pain was given as epigastric in nature, often substernal in origin; in nine it was depicted as cramp-like; generalized to the entire abdomen, and in one it was localized to the right lower quadrant, and in one to the left upper quadrant. Vomiting, which was usually severe, was present in thirty-four cases. Twenty-two patients suffered from severe obstipation, and the distention in a large percentage was unrelieved by enemata.

The general appearance of these patients which may be used as an index for surgical procedure seemed to vary directly with the extent and type of pathologic involvement. The average case appeared shocked and acutely ill, and four were in apparent collapse. The pulse though small was not extremely rapid, the temperature was not unduly elevated, in fact a high temperature was unusual, and the respirations were slightly increased. Clinical evidence of jaundice was rare. What the Van den Bergh tests might have shown is not known, but it may have thrown some additional light on the relationship of transient biliary obstruction to the etiology of acute pancreatitis. Cyanosis has been commented upon by others. In this survey it was noted four times. While cyanosis might be due to an anoxemia associated with insufficient aeration secondary to diaphragmatic paresis incident to acute pancreatic pathology, there is still another possible explanation. Inasmuch as the liberated lipase splits fat, there may be an increase in the amount of free blood fat with multiple fat emboli to the lung. As a matter of fact, the frequency of lung involvement in these cases is well known and it is barely possible that the bronchopneumonia occasionally present may be embolic. Three cases in this series were diagnosed on admission as primary pneumonia before it was apparent that the lung involvement was secondary to subdiaphragmatic pathology.

The abdominal examination disclosed tenderness in the right upper quadrant in seventeen, epigastric tenderness in two, localized about the umbilicus in five and generalized throughout the abdomen in eight. Tenderness in the left loin is supposed to be characteristic. This was noted in seven cases. It may be due to distention of the lesser sac with exudate or possibly to involvement of the tail of the pancreas or both. Rigidity was present in the right upper quadrant in thirteen, left upper quadrant in three, confined to the upper abdomen in two, and generalized in eight. Distention was noted in eighteen patients. In seven cases a mass was palpable in the

area of the right upper quadrant, and operation disclosed that this was an enlargement of the gall-bladder in six instances, and in one a pancreatic abscess. Free fluid by physical sign may or may not be present.

The leucocyte count was high. In 75 per cent. it was over 15,000, and in 36 per cent., above 20,000. The average was about 20,000 white blood cells with a leucocytosis of about 85 per cent. The urine examination was rarely of significance. Bile was present on four occasions and sugar twice.

Abdominal puncture<sup>9</sup> which was employed several times when positive was really of great aid. The intraperitoneal aspiration of a characteristic oily beef juice fluid is almost pathognomonic of acute pancreatitis. It was performed seven times by Doctor Neuhoef and Doctor Cohn and this was positive in six instances. This test as an aid in differential diagnosis has not been given the place it deserves in the evaluation of abdominal pathology.

This review of the clinical history and physical examination makes it quite clear that the diagnosis of acute pancreatitis must really be made by exclusion and it must be differentiated from the acute cholecystitis, gastroduodenal perforations, acute intestinal obstruction, acute appendicitis and other conditions. The text-book differentiations of these are well known and need no discussion here.

When once a diagnosis of acute pancreatitis is made or suspected, the question arises as to procedure. Recently several have advocated quite strongly the non-operative treatment, feeling that the mild cases invariably subside without any sequelæ and that many of the fulminating cases would do better if operated after the disease had localized and abscess formation had taken place and the period of shock had passed. The autopsies of four of five unoperated cases are silent witnesses as to the efficacy of this procedure. There is no doubt that some cases have recovered with the expectant treatment; a few have done well following the drainage of a localized abscess after an acute attack, and several would have died regardless of surgical intervention, especially in those cases in which the entire pancreas seemed almost immediately converted into an oedematous necrotic mass. But what harm is done by surgical exploration? There seems very little to be lost and much to be gained and when it is all weighed, many more cases have probably died from skillful neglect than from active intervention. Acute pancreatitis cannot be considered as a medical disease and the expectant treatment has no more a place here than it would have in acute appendicitis or perforated ulcers.

In this series, the majority of the cases were explored under general inhalation anæsthesia. Spinal anæsthesia, provided that the blood pressure is not too low, is probably the best. Inhalation anæsthesia is to be avoided if possible, especially if any credence is to be placed upon the frequency of embolic lung manifestations. Inasmuch as the majority were diagnosed as gall-bladder disease, an upper right rectus muscle-splitting incision was made, and as a rule this afforded adequate exposure. The findings in the main were quite characteristic. Free fluid varying from a clear amber exudate to the beef broth fluid so characteristic of this condition was present in 45 per

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cent. of the cases. It was serous in two, bloody in fourteen, and chocolate colored in four. Its general appearance and consistency may be taken as an index of the stage of pancreatic involvement. Fat necroses which are so pathognomonic of the condition were observed at operation in thirty-two cases and were not noted in fourteen. In one of these, the abdominal wound showed evidences of this after operation, in seven the necroses were intraperitoneal and in seven intra and retroperitoneal. Retroperitoneal fat necroses are a serious complication and their presence increases the degree of protein intoxication. In five autopsies the fat necroses were absent, although three of these were cases of secondary pancreatitis. As is well known, these are caused by the action of the liberated lipase on fatty tissues splitting them into fatty acids and glycerine. The lipase is freed during the digestion of the pancreatic cells by the activated trypsinogen. The free fat then combines with the calcium of the blood and tissue juices to form the characteristic lesion. Their extent, locations, number and size vary from a pin-head to a diameter of several millimetres, but their number and extent is no evidence of the severity of pancreatic destruction. They have been known to suppurate, but in the majority of cases they generally disappear. One case operated years later for chronic cholecystitis showed absolutely no evidence of this condition although at the primary operation the fat necroses were described as extensive.

The gall-bladder, as has been previously mentioned, invariably presents some pathology. The pancreas was described as hard and enlarged in the majority of cases, but after all it is always rather difficult to judge the pathology of this retroperitoneal organ simply by the sense of feel and to visualize it is rather a hazardous procedure in patients sick as these. Occasionally if suppuration was present, the pancreas gave the impression of being elastic or cystic, and in a few cases in which a localized abscess was present, fluctuation was felt.

However, the question of the proper operative procedure is still an open one and a problem which should receive serious consideration. What these patients are suffering from is really an acute protein intoxication, the result of the autolytic action of liberated pancreatic secretion and the toxic products from a necrotizing pancreas. The object of surgical intervention should be the free external drainage of the liberated pancreatic secretions and the products resulting from their digestive action, the possible protection of the pancreas against any further destructions and the removal, if possible, of the factor causing the pancreatitis.

The free drainage of the toxic protein products presents some difficulty.

A certain proportion of these poisons may be removed by a thorough and complete suction of the free fluid within the peritoneal cavity at the time of operation. At times, in mild cases, as evidenced by the clinical reaction of the patient and the operative findings, this may be all that is necessary. In severely toxic cases, however, this will not suffice. Ottenberg and Wilensky<sup>10</sup> have suggested exsanguination transfusions to further reduce the protein



intoxication of the blood. But the problem of actual pancreatic drainage is not easily solved. The fact that there are fat necroses means that there must be some free drainage from the pancreas. In some cases, this is sufficient; in others, not. Drainage, however, could be theoretically augmented by a liberal and free incision of the capsule of the pancreas. This is impractical as a rule, not only because of the anatomical location of the gland, but mainly due to the peculiarity of the tissue, which, if traumatized, will digest itself. Pancreatostomy is a heroic procedure and, with the proximity of the splenic vessels, it is fraught with dangers disproportionate to the advantages derived. Three of the four cases in which it was done, died. While incision of the pancreas is not feasible, the peritoneum overlying the pancreas may be bluntly incised and rubber-dam drainage employed. This approach may be either through the gastrocolic or gastrohepatic omentum. This manœuvre not only relieves the tension of a swollen œdematous pancreas, but provides an exit externally for the liberated secretions and minimizes the danger of retroperitoneal invasion. This retroperitoneal invasion is a great menace and contributed greatly to cause of death in 33 per cent. of the autopsied cases in which it occurred.

In addition, in these severe cases, a cholecystostomy is usually indicated for more reasons than one. There is no doubt that the surgery of acute pancreatitis has been justly influenced by the association of this condition with gall-bladder disease, and for this reason in any case of acute pancreatitis the gall-bladder and its ducts should receive the most careful and painstaking exploration. In fact many surgeons claim that biliary disease is a precursor of acute pancreatitis, and the prophylactic treatment of acute pancreatitis is the early eradication of preëxisting gall-bladder pathology. As a matter of fact, in this series no case of acute pancreatitis was observed in a patient who had had a previous cholecystectomy. But the treatment of the acute disease should have little to do with the radical treatment of the chronically inflamed gall-bladder. In the majority of primary cases, although it is extremely difficult to prove, the pancreatitis is probably caused by the retrojection of infected bile up the pancreatic duct. This retrojection of bile is probably a transitory condition, for the common bile has never completely occluded as evidenced by the fact that clinical jaundice was present in only four cases even though the common duct was dilated in seven instances. However, it seems safer to afford external drainage of the bile. At the same time, it affords a means of removing stones from a gall-bladder, and in two instances in which the gall-bladder was described as normal and without stones, calculi were subsequently discharged through the cholecystostomy tube—in one case as many as twenty. It is barely possible in these two instances, as in many others, that the origin attack may have been initiated by a stone which was temporarily caught at the papilla and subsequently passed. In another instance in which no stones were found at operation and nothing further done than exploratory coeliotomy, a cholecystectomy was performed one year later for innumerable small stones. In addition, a cholecystostomy relieves tension

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and spasm on the papillary region of the duct, thereby promoting a more free drainage from the pancreatic duct, and in those cases in which the common duct is obviously dilated, the external drainage of bile decompresses a compromised liver and protects the pancreas from any further biliary irritation. It seems more than coincidence that the seventeen cases in which cholecystostomy was done for acute pancreatitis should have been productive of the lowest mortality, 35 per cent., while those cases in which exploration with simple drainage was done had a mortality of 55 per cent. While cholecystostomy is rather an indirect way of diverting a stream of bile from the pancreas, the simplicity of its performance has more to commend it than the better drainage obtained by a choledochostomy which is more time-consuming and dangerous. If, however, there is definite evidence of common duct obstruction and dilatation is present, the duct should be thoroughly explored, especially the papillary area, and whether calculi are present or not, choledochostomy is indicated.

Those cases seen late in the course of the disease and in which abscess formation has taken place may be treated as simple intraperitoneal abscesses. Drainage may be performed in either one or two stages. Some surgeons in an effort to avoid soiling the general peritoneal cavity pack down to the abscess and then, after sufficient adhesions have taken place, drain. In those instances in which the abscess has arisen in the tail of the pancreas, a retroperitoneal approach through a lumbar incision has met with success. In this series, four cases of pancreatic abscess were primarily drained, two through the loin, and two abdominally, three of which recovered.

The prognosis in all cases of acute pancreatitis is grave. In this series of forty-six operated cases, twenty-three survived. Seventeen of these made what may be called an uneventful recovery with the exception that one drained bile for rather a considerable period, and the other developed post-operative fat necrosis of the wound. The hospital stay of the average case in this series was about twenty-five days. Six of the cases had rather a stormy convalescence. One case in which a pancreatic abscess was drained through the lumbar route ran a septic course for days, but eventually cleared; another, in addition to signs of a generalized peritonitis, developed a definite left lower lobar pneumonia. Two cases in which the gall-bladder was described as normal at the time of operation subsequently drained stones through the cholecystostomy, and one case was accompanied by the picture of a Charcot fever. One patient sloughed away a great part of the pancreas and it was 110 days before the pancreatic fistula closed. The longest stay was that of over 300 days, in which the pancreatitis followed an automobile accident seven days before admission. Operation disclosed a large hæmatoma of the pancreas which was drained. The patient was acutely ill for months, developing many intraperitoneal abscesses, two of which required subsequent drainage. These abscesses probably followed a peritonitis, although it is barely possible that they resulted from suppurating fat necroses.

Of the cases which died, over half succumbed within the first twenty-four

hours. One case died in five days from an increasing blood sugar and uncontrollable acidosis. Others succumbed on the tenth, twelfth, thirteenth and twentieth days from peritonitis and pancreatic necrosis. One patient died thirty-three days after operation from what was clinically a subphrenic abscess. While the apparent cause of death in 50 per cent. of the cases was shock, autopsy findings in many revealed the picture of an acute hæmorrhage pancreatitis. In fact a careful review of the seventeen autopsies in primary cases demonstrated quite conclusively that death resulted from the actual destruction of the pancreas, sixteen dying from pancreatic necrosis. In six cases the entire pancreas had completely sloughed and was lying in an abscess cavity.

*Summary.*—Acute pancreatitis in this series was coincidentally existent with disease of the gall-bladder as proven by operation or autopsy in 85 per cent. of the cases. However, in a series of 1280 cases of biliary-tract disease exclusive of malignancy or stricture, acute pancreatitis occurred in only 2.6 per cent. of the cases. It seems more than likely, then, that the etiology of acute pancreatitis was dependent in the main upon those variations of the pancreatic and bile ducts which favored anatomically the retrojection of infected bile into the pancreas.

The clinical picture and physical findings of this condition were quite variable, and the diagnosis in most cases must be made by exclusion. When the condition is suspected, a diagnosis might be greatly aided by an abdominal puncture and aspiration of the typical oily beef-juice exudate.

Acute pancreatitis is invariably a surgical disease and operation should aim to remove the toxic protein products, to relieve pancreatic tension and thereby lessen glandular necrosis, and, if possible, to remove the cause of the pancreatitis. Thorough aspiration of the peritoneal cavity, drainage down to the pancreas and cholecystostomy are invaluable procedures to cope with the condition at hand, and in extremely toxic cases, exsanguination transfusions might be of definite value.

Death is due in the majority of cases to the toxæmia of an acute pancreatic necrosis.

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## A CLINICAL STUDY OF CALCIFIED NODES IN THE MESENTERY\*

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JUNE 18, 1916, the writer operated on a woman of thirty-one years for recurrent right inguinal hernia that eight years previously had been repaired elsewhere. Nothing first hand was known of what the operator found at that time. For three weeks she had had pain in her right lower quadrant. She thought it due to the hernia because it was worse when the hernia "came out." The pain, however, was not in the region of the hernia, but above it, and was associated with tenderness slightly above and internal to McBurney's point. It was thought that her appendix, descending into the hernial sac, or in some other way, might be the cause of the discomfort. When the internal ring was opened, an atrophic appendix was easily delivered and removed. Before closing the sac, a finger was inserted to explore the pelvis and lower abdomen. A mass like a marble was felt just above the pelvic brim on the right side. A calcified mesenteric node was exposed, measuring 3 centimetres in diameter, to which the omentum was firmly attached. From the node passed a cordlike band to the mesentery of another portion of the intestine. Beneath this band was caught a loop of small intestine, measuring about 35 centimetres in length, moderately distended and very definitely constricted beneath the band.

The omentum was freed, band divided, the loop of intestine released and the node removed. Six months later this woman had gained 16 pounds and was seen nineteen months after operation quite free of symptoms. (Case V.)

This fortuitous finding of thirteen years ago prompted observations on calcified mesenteric lymph glands to see whether they were associated with clinical symptoms that might erroneously be considered something else. This case and several others were included in a paper read at a stated meeting of the New York Academy of Medicine in 1923.

During the past thirteen years, patients complaining of certain types of abdominal pain, and suspected of having calcified mesenteric glands, have had abdominal X-rays taken to discover their presence. In fact, this has become practically a routine procedure of the Presbyterian Hospital and it seems worth while to record the reasons why.

In the first place, the presence of calcified lymph glands in the abdomen, whether in the mesentery or in the retroperitoneal spaces at or near its root, are an indication that at one time or another tubercle bacilli have passed through the intestinal wall and caused tubercles to form, that became scarred, isolated and walled off by calcium salt deposition. Calcification of lymph nodes due to other cause is, by common acceptance, so extraordinarily unlikely that this phase of the subject will not be dealt with here.

How frequently do tubercle bacilli affect the intestine and its glands?

If this be frequent, it is important, for it makes a clinical entity that must be every day taken into consideration.

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\* Read before the New York Surgical Society, December 11, 1929.

Autopsy figures show that at death intestinal tuberculosis occurs in from 50 to 80 per cent., or even more, of all cases of pulmonary tuberculosis. This means, for example, that of 4780 patients who died from pulmonary tuberculosis in New York City during 1924, 2300 to 3800, or more, had intestinal tuberculosis, a complication seriously affecting their nutrition and, *a priori*, their chance of recovery. In Paris in 1922, 6884 persons died from pulmonary tuberculosis and, of these, 3400 to 5500, or more, had intestinal tuberculosis. Calculated in a similar manner, from 40,000 to 63,000 persons with pulmonary tuberculosis had intestinal tuberculosis at death in the United States in 1923, and from 16,000 to 25,000 in England and Wales in the same year.

Drolet has estimated that about 18,000,000 patients died from pulmonary tuberculosis through the world during forty years. Of this number, from 9,000,000 to 14,000,000 had intestinal tuberculosis.\*

These figures, stupendous as they are, refer to manifest intestinal tuberculosis, a disease considered for years as fatal as cancer because diagnosed late, and only, within comparatively recent years, recognized in its earlier stages when more amenable to treatment. Our subject, however, deals with tuberculosis of the intestinal tract that has not killed but been conquered. It is infinitely more common than is generally supposed and begins pre-eminently in childhood.

In Drs. Dunham and Smythe's most excellent paper † in June, 1926, Still's statistics are quoted,

In discussing abdominal tuberculosis in children, Still ‡ points out that the condition is not common from the clinician's standpoint, "but from the more reliable estimate of the pathologist, abdominal tuberculosis would seem to be one of the commonest of all tuberculous lesions in children." "My own statistics," he writes, "show that 88.3 per cent. of tuberculous children have tuberculous lesions in the abdomen,"

and of 120 children with positive tuberculin tests, twenty-one or 17 per cent. showed calcified glands by X-ray, the youngest four years, the oldest 12 and one-half years—average, a little under seven years. More recently Doctor Dunham found that of 1152 children brought for various reasons to the clinics, and routinely X-rayed, 128 showed calcified mesenteric glands, *i.e.*, about 11 per cent.

Abdominal tuberculosis in children should, perhaps, be more common from the clinician's standpoint than it is.

If 11 per cent. of these children showed calcified glands, how many more had tuberculous glands not calcified is hard to say, but it indicates that it must be considered as one of the frequent diseases.

One naturally expects this frequency to greatly vary in different parts of the world. This is borne out by the disparity of figures § between autopsies done in St. Louis, where no evidence of healed tuberculosis was found in 143 cases, children and adults, and 25 per cent. of the British soldiers, who showed these evidences at autopsy.

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\* Brown and Sampson: *Intestinal Tuberculosis*, p. 103, Lea and Febiger, 1926.

† *Am. J. Dis. Child.*, vol. xxxi, pp. 815-831, 1926.

‡ Still, G. F.: *Common Disorders and Diseases of Childhood*, Ed. 3, pp. 423 and 427, Henry Frowde, London, 1920.

§ Opie, A. M.: *Rev. Tuberc.*, vol. iv, p. 641, 1920.

Calcified mesenteric tuberculous glands are plentiful in New York and its vicinity.

There is good reason to believe that calcified mesenteric nodes represent what those most expert in the study of tuberculosis would call Primary Tuberculosis infection as contrasted with the phenomena associated with reinfection or secondary tuberculosis.

Children and young people with tubercle bacilli in their mouths, breathing bacilli into their lungs or swallowing them, have them swept from the tissue spaces beneath their epithelial surfaces through the lymphatic channels to their cervical, tracheo-bronchial, or mesenteric lymph nodes. There they may remain, form tubercles, become walled off and calcified after varying degrees of coagulation necrosis.

Primary infections of this sort in young children may be human or bovine in type. Primary human type infection may occur at any time. Bovine infection seems to be confined to childhood.

PARK and KRUMWIEDE\* found in, I abdominal tuberculosis cases, II generalized tuberculosis of alimentary origin, and III generalized tuberculosis, including meninges, of alimentary origin, when the children were under five years, there were 22 instances of the human type as compared with 31 of the bovine. In children from five to sixteen years, there were 10 human and 10 bovine. In adults, sixteen years and over, 21 were human and 4 bovine. Although primary infection to human or bovine is of importance in seeking the source of primary infection, the altered reaction manifested by the body after such a primary infection, or its allergic state, is similar in its response to reinfection in either instance. It would seem, according to those versed in immunity, that reinfection by human tubercle bacilli where the primary infection has been bovine may be quite as disastrous as if it had been human from the start.

ZINSSER† states that "in a community supervised more closely than usual, the work of Public Health Service bacteriologist in Washington revealed 6.72 per cent. of samples of market milk infected with tubercle bacilli. This percentage is probably very much lower than that which would naturally be found in districts with a less well developed dairy supervision, and in some of the poorer farm districts of the country the cattle tuberculosis situation is actually appalling."

These primarily infected nodes may not become so completely walled off, but serve as distributing foci. If bacilli be distributed from them by direct extension, by retrograde lymph spread or through their efferent channels to the blood stream by way of the thoracic ducts, or if new tubercle bacilli be inhaled or swallowed, reinfection of previously existing primary sites may occur. If the immunity provided by the primary infection be adequate, little harm may be done. If the number of new bacilli be great and they gain access to the periphery of already existing lesions, secondary reinfection may cause devastating, often ulcerating and cavity forming, visceral lesions.

The allergic state created by primary infection, *i.e.*, the changed condition of the body and the different manner in which it reacts after an initial infection with tubercle bacilli, together with the amount and virulence of the reinfection, are dominant determining factors in the subsequent clinical

\* Jour. Med. Research, October, 1910.

† A Textbook of Bacteriology, p. 506, D. Appleton & Co., N. Y., 1927.

course of tuberculous children as they advance into adolescence. Obviously, it is of importance to recognize the fact that a vast number of children have primary infections, so as to devise every possible way of guarding against serious secondary reinfection. Many cases of calcified mesenteric glands do not show complete walling off with calcium, some have areas of coagulation necrosis and, more rarely, active areas of tubercle formation in their immediate neighborhood. Allergy means altered reaction. Young people with partially calcified glands, may be in an allergic state in relation to tubercle bacilli. The reactions to reinfection they manifest in and about their primary lesion may be and probably are quite different in degree and intensity from reactions shown at this primary infection. That they may show a more intense reaction and perhaps a better immunizing activity if the secondary dosage be very minute, seems possible, but quite the opposite, if the reinfecting dosage be large, so that lesions such as ulcerations, cold abscesses and cavities may result, forerunners of the beginning of the end.

In the gastro-intestinal tract, bacilli little affected by natural gastric juice\* and showing "in alkaline media no apparent weakening of virulence," † pass readily by the stomach, where little absorption takes place, and rapidly through the duodenum and jejunum, where food, mixing with digesting fluids, is being prepared for use. The ileum is that part of the digestive tract where the first delay in the contents of the alimentary canal for effective absorption naturally occurs. There, quite as do typhoid bacilli, tubercle bacilli first pass the epithelial barrier to the submucosa and exert their primary action in the solitary lymph follicles or Peyer's patches and make tubercles in the mesenteric nodes. Brown and Sampson depict little mammillations that are the evidences of healed lesser grades of tuberculous infection of the lymphoid structures in the submucosa of the small intestine. Just how many instances of calcified mesenteric glands might show these or less evidence of intestinal wall lesion would require very minute search of the intestinal wall corresponding to the areas drained by the particular nodes involved. The writer at operation has often looked for gross evidences of scarring in the intestinal walls, but found none. This means but little, for the gut was not opened, and even if it had been, the study would have had to be a microscopical one. It is probable that many, if not most, children and young people soon after their mesenteric glands have been infected with tubercle bacilli show no evidence of disease in the intestinal wall. One suspects if such mammillations be found that a reinfection of mild degree had occurred in childhood and healed.

Calcified mesenteric nodes are of surgical importance.

1. It is a frequent finding, if a normal appendix be found at an operation for chronic appendicitis.

2. It may closely resemble appendicitis, cholecystitis, gastro-duodenal

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\* Fernbach, E., and Rullier, G.: *Rev. de la tuberculose*, vol. iii, p. 160, 1922.

† Baldwin, E. R., Petroff, S. A., and Gardiner, Leroy S.: *Tuberculosis*, Lea and Febiger, Phila., 1927.

## CALCIFIED NODES IN THE MESENTERY

ulcer, intestinal obstruction, renal calculi, diverticulities, pelvic inflammation, vertebral and sacroiliac disease as well as other clinical entities, causing abdominal pain.

3. The need for an operation, the type of incision, and the operative procedure may be determined by a knowledge as to whether they exist or not.

4. They may determine a post-operative result and proper after-treatment.

5. They may indicate an unsuspected advanced abdominal tuberculosis. They indicate that the patient once had a primary tuberculous infection.

6. In an adult they may give the clue to ill health that has existed since childhood.

7. They may be associated with peritoneal bands or adhesions requiring correction.

Calcified mesenteric lymph nodes and other manifestations of abdominal tuberculosis have frequently been experienced by the members of a gathering such as this. Recently Dr. Ross Golden has written an excellent review of the subject.\*

Many cases have no clinical symptoms, and the nodes may be discovered when the patient is being X-rayed for something else. Careful analysis of their early history, however, may reveal a very suggestive story of the original infection.

Many cases do present a clinical syndrome. There may be a period in childhood when they were definitely below par, usually under weight, always going to the doctor, always needing a tonic, never quite cured of anything and always convalescing slowly, and peculiarly prostrated with measles or influenza. No diagnosis seems wholly satisfactory—acidosis, grippe, malaria, bilious attacks, intestinal influenza, typhoid fever and appendicitis are some of the mistaken diagnoses used for the early primary stages of these tuberculous infections and their subsequent attacks. They feel their best when living a quiet life in bracing, stimulating climate, during fall of the year and at top weight.

Most cases giving symptoms are seen in young women.

The longer people go with calcified nodes that give no symptoms, the less likelihood there is that they will ever complain. In other words, if symptoms don't appear by young adulthood, they probably will never appear.

Acute abdominal symptoms and signs without leucocytosis or increased polymorphonuclear count should always arouse suspicion of tuberculous mesenteric node infection, whether calcified or not, especially if the pulse and temperature be low.

It is characteristic for these patients, who do give symptoms, to appear never to be wholly well. Just when it would seem that they had swung free, that a period of rest had quite set them on their feet, they crack under the pressure of life's routine. Whatever they ought to be doing, they find they can't quite do.

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\* American Journal of Roentgenology and Radium Therapy, vol. xxii, no. 4, October, 1929.



To varying degrees, young adults or children with these nodes may be ill-nourished. They may enjoy food, eat naturally, even eat more than their associates, yet remain under weight and lack endurance. They are troubled with abdominal pain. It is not confined to any one place, so that it may suggest many other clinical entities. But it is more often in the right lower quadrant than anywhere else. This is due to the ileocæcal group of glands being involved most often. It may be colic, pain, going as fast as it comes. It may be a persistent, aching, nagging discomfort that sometimes becomes sharp and severe. When this occurs, tenderness accompanies it. This tenderness can usually be accurately charted first by gentle percussion over the whole abdomen as though one were percussing the chest. Subsequently, by pressure with the thumb, a study of deep tenderness is desirable. One of the striking features is to find but little tenderness at McBurney's point. Some may be present there. Inside and above the point, however, is where maximum tenderness is most characteristic. When the pain radiates, as it does not infrequently, it is to the back, "up the back," and into the thigh.

One patient's pain came on after an afternoon of tobogganning; another after watching and cheering championship tennis and standing in the train all the way home; another after carrying a heavy weight several blocks on leaving a train at the Grand Central Station; a child played hard and ate apples; one man, seen by an extraordinarily able clinician, was suspected of kidney stone because of the pain in his back and thigh; many young girls after leaving school and its regularity go through an era of strenuous work or exhausting play and then complain. Pain in the past is frequent, and a patient's story cumulates as his memories freshen. Often pain is recognized as an old enemy, sometimes a constant companion. In fact, people may become so used to it as to regard it as natural and fail to appreciate they are suffering. There are many who have attacks, but, when pressed, state they are conscious of "something there" all the time. One young woman in a plaster cast for most of a summer for pain in her back, had a round, smooth shadow in her X-ray film that was entirely overlooked and considered an artefact or a button in her dress.

One of the striking clinical features is the way these patients pay the penalty for physical or dietary stress or strain. While active, during athletic exercise, while keyed up by the excitement of whatever stress may be undertaken, the pain may be absent. Later, when relaxed, the same night, the following day, the penalty is paid. This feature is not invariable, indeed no single symptom is that, but night discomfort after a hard day is too noticeable a feature to be overlooked. These nodes are very close to the great veins of the mesentery, indeed the vessels seem wrapped about them. Venous passive congestion in people with these nodes seems to bring pain when such congestion in people without the nodes does not.

Some cases complain of pain apparently due to peristalsis, so that as soon as they take food they get discomfort that may remain till their next meal.

Many a case has no pain on vacation. Rest, change in work, diversion,

eating different food, breathing different air, change in altitude, and last, but by no means least, opportunity for sun exposure, *i.e.*, those factors that create "metabolic revolutions," greatly influence such cases and are of as suggestive diagnostic, as they are of therapeutic, value.

Vomiting does not often occur, but nausea does, and is usually associated with the attacks of pain. When vomiting does occur, its history may be rather pathetic. Much vomiting in childhood due to unsuspected mesenteric nodes has been wrongly called acidosis. A young man, whose childhood had been shrouded with all the safeguards doctors and protection great wealth could provide, stated there were but few days in childhood that he didn't vomit once in the twenty-four hours. He had come to feel that it was just a bit of his life's routine. In a woman of fifty, precisely the same story was given. Most of her life had been dotted with visits to doctors and sanatoria to find out why she vomited. A loop of ileum was bound fast to her calcified node, so tight that knife dissection was needed to free it.

## HOW THE LESION CAUSES SYMPTOMS

1. Due to adhesions, bands and contractures. These are usually chronic ileus symptoms or symptoms referable to an abnormal tug or strain on the parietal peritoneum wherever the scar tissue may exist. These secondary changes produce symptoms readily appreciated by all.

2. Due to other intestinal and other lymph node lesions of like nature to itself—but active, not scarred nor calcified. The demonstrable calcified areas may be the silent sentinels or indicators of active disease in the neighborhood.

3. Due to the presence of the nodes alone. Apparently this can happen.

It would seem that such lesions indicate a handicapped area in one of the most important functioning areas of the body, and that when the individual as a whole, or the area in particular, is subjected to excessive stress or activity, or infection, it will not function, it breaks down, and so-called intestinal symptoms appear that are not wholly characteristic of any type conditions, *e.g.*, gall-bladder and appendix, we are all familiar with.

1. The lymph and lacteal drainage for the corresponding part of the gut has been diseased beyond repair. The node has been walled off as a foreign body as well as the tissues can do so. A rearrangement and compensatory mechanism has had to be established. The efficiency of such makeshift is generally less than the original arrangement.

2. The same is true of the blood-vessels to and from the nodes and in their immediate neighborhood.

3. Damage may have occurred to the sympathetic trunks in the region and their nutrition been impaired, giving rise to symptoms that may be spastic or paralytic, as the case may be.

4. If there be reinfection, or stress and strain inflicted on such an area, the possibility of rekindling old areas kept in a state of allergy so that intensified, altered reactions of nearly walled-off infection occurs, becomes a

probability. This is, of course, a common happening in the cervical tuberculous glands we can see.

The diagnosis of the presence of these nodes is made by X-ray films of the abdomen, preferably after the large intestine has been made as free of gas and fæces as possible. A good way is to give

Castor oil	$\frac{1}{2}$ ounce
Elixir lactopeptin aa	$\frac{1}{2}$ ounce
Essence of peppermint	5 drops

the afternoon of the day before and take the film the following morning. One case showing no calcification at the age of seventeen showed definite calcification at twenty-one. Cases followed in childhood would probably often show this phenomenon. Their flaked, mottled, sometimes ringed appearance, is familiar to all experts in X-ray. It may require repeated films, stereos, transverse as well as *antero-posterior* views and even filming in prone and supine positions to complete the study. They may be seen by fluoroscopy, but many times when calcification is slight, cannot.

Whereas the diagnosis of their presence is relatively simple, the question as to whether they may be causing symptoms in any individual case is not.

A truly difficult decision arises in cases where the symptoms resemble disorder in the appendix. If the appendix has been removed, this, of course, does not obtain. There are many instances, however, when a patient is referred to the surgeon with a diagnosis of so-called appendicitis and an X-ray film shows calcification to the right of the lower lumbar vertebræ. In most of these cases, true inflammatory attacks with fever, leucocytosis, vomiting, persisting tenderness, and perhaps spasm have been absent. If inflammatory attacks have occurred, the nodes are less under suspicion. Occasionally, if the appendix fills with barium in a routine gastro-intestinal study, its failure to empty, its beaded appearance, the possible evidence of fæcoliths, its abnormal shape or evidence of kinking, adhesion, or dilatation, may contribute evidence that it is diseased. But often one cannot differentiate these two conditions in spite of painstaking effort and conservative treatment over a considerable period of time, till an operation be done.

The writer is not a believer in relinquishing one of the most valuable incisions in surgery, the McBurney incision. It is vastly superior for appendicitis to the right rectus incisions in most cases. If calcified nodes be present, however, and the appendix be destined for removal, a right rectus incision is to be preferred. Examination of the mesentery with node removal may be difficult through a McBurney incision, but easy through the right rectus route.

If an apparently normal appendix be found and removed, the question as to whether the node or nodes should be removed becomes acute. If the operator believes, from the clinical story, that the nodes have been a probable cause of the symptoms, if they can be removed readily, and with minimal risk, if conservative treatment has failed, and if there be no evidence of

widespread tuberculosis, it is wise to remove them. There are many, many cases, who never need to have these nodes removed, but there are some who do. This opinion is based on cases that have given symptoms after appendectomy, cases that have had pain referred to other parts of the abdomen than the right lower quadrant, and cases where operation has been performed at a time the patient was having severe and persistent symptoms and the appendix found to be quite normal.

Where associated adhesions or bands are present, these need, of course, to be dealt with according to the principles covering such conditions.

Great care should be taken in excising these nodes to do no more damage than possible to the structures in the mesentery. Small delicate scissors, fine clamps and thumb forceps, with fine needles and catgut are very helpful. If the nodes are behind the posterior parietal peritoneum, they must be approached from in front, but if they are between the leaves of the mesentery, they can often be approached through both leaves, for the nodes lie on either side of the vessels and it makes the dissection simpler. The incision in the mesentery should be sutured precisely, with a continuous Cushing type of suture so as to leave no raw surfaces.

Most cases we have studied have shown no tubercle bacilli on guinea-pig injection. A few have shown them. Most show no evidences of active tubercles, but a moderate number show cheesy coagulation necrosis. Only a few show active tubercles. The condition being described usually represents the terminal stage of a tuberculous infection, but evidences of earlier stages and of superimposed reinfection are not uncommon.

Conservative treatment should precede surgical removal, unless the appendix demands removal. In such cases one may not be able to wait for this to be undertaken. If these nodes be found in a case with true acute inflammatory disease in the appendix or elsewhere they should not be removed. The risk of introducing an acute streptococcus or colon bacillus or other infection into the retromesenteric tissues should not be taken.

Conservative measures comprise—planning a daily life free from excessive dietary or physical stress and strain—sunlight or artificial heliotherapy, rest, diversion, changes in climate, occupation, or environment, if essential, high caloric food intake—cod liver oil and shielding the patient from secondary pyogenic infections or secondary tubercle bacillus reinfection, as far as possible. If there be much colic, it may be wise to use such sugars and carbohydrates that are readily absorbed in the small intestine and never get a chance to get to the colon and ferment. This means more glucose and less of the other sugars and coarser carbohydrate vegetables. Acute attacks of pain may sometimes be controlled by heat, by an enema, or by a dose of aspirin and pyramidon. The ultra-violet light, two to three times a week, has been one of the most valuable artificial measures employed.

From having pain over a long period of years, often diagnosed incorrectly, some patients get thought habits about themselves that are pitiable—discouragement, self-pity, and fear, combined. They act as canaries let out

into a room from their happy homes in gilded cages. No matter whether the cage door is open or not they flutter and fly about frightened at what they can't understand.

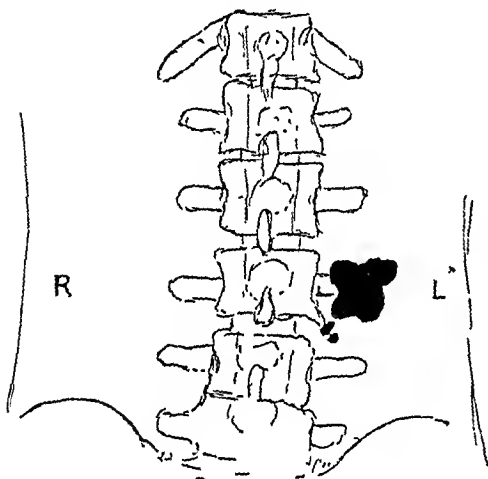
In such instances wise handling by one skilled in psychiatry may do more good than anything else.

It is not enough for surgeons or physicians to disregard either the significances of calcified mesenteric lymph glands or their presence. They constitute a clinical entity of major importance of frequent occurrence and in carefully selected cases, surgical intervention.

CASE I.—*Calcified nodes resembling acute ileus.*

P. H., No. 39075, trained nurse, a woman, aged twenty-six years, single, admitted September 10, 1918, with history of two main attacks, first one year ago, second six years ago. During the past year lost 30 pounds. One year ago had sudden pain in middle and right side of abdomen for ten days, since when no real attack until six days ago, when in her right side and back, radiating to chest, was a dull, dragging, aching

pain, which was made better by drawing legs up, and more noticeable when she stretched them out. She was sent to the hospital from another hospital with a probable diagnosis of acute appendicitis, inasmuch as she had had vomiting on the first night and the second and fourth days following the onset. Her bowels, however, had moved every day. The leucocytes were 6,200, polymorphs 48 per cent. She was considered by the examining physicians on admission as a case of acute appendicitis, gall-bladder disease or possibly twisted ovarian pedicle, but because of the blood-count and inability to localize the tenderness, she was sent to the ward for observation. She vomited bile. On the next



day vomiting continued; she had colic, her abdomen was flat, but there was *left-sided tenderness outside umbilicus*, as well as tenderness on her right side. A few red blood cells were found in the catheterized specimen, but subsequent smears and guinea-pig inoculations were negative. Von Pirquet test was moderately positive and was immediately followed by a sudden rise of temperature to  $102^{\circ}$ , though she had had practically no temperature before, nor did she have any after. Dr. W. W. Palmer saw her in consultation and thought that there was a mild tuberculous process at the left apex. Some infiltration was reported in this region at X-ray. The X-rays of her abdomen showed a large and a smaller shadow in the left abdomen rather characteristic of calcified mesenteric nodes. There was almost no tenderness at McBurney's point.

At operation two masses of calcified glands were removed from the mesentery of the small intestine, near its base. An omental band was divided from the summit of the sigmoid loop. The appendix, which was not inflamed, though angulated at its distal centimetre was removed. A moderate number of other small soft nodes were present in the mesentery. Guinea-pig injection from the calcified nodes was negative.

For over a year she did well and gained 40 pounds and had no further symptoms. Subsequently, in the neighborhood of a year and a half, she was operated on in the Brooklyn Hospital for acute ileus with a resection of eighteen inches of gut, following which she had phlebitis. She twice reported to the Out-patient Department here on account of her phlebitis.

## CALCIFIED NODES IN THE MESENTERY

She was last seen 116 months after operation in excellent health.

1. It is hard to explain the right-sided pain except as colic from a partial ileus due to the band to the sigmoid.

2. The tenderness on left side was not noted till late. It was then very definite.

3. The persistence of the vomiting was disturbing and thought to be reflex.

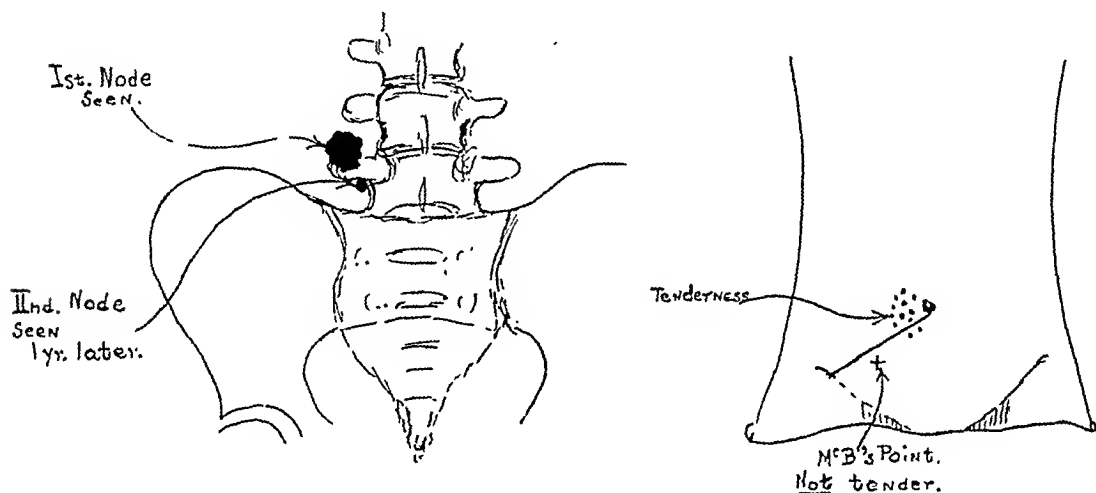
4. The appendix was not inflamed, though slightly angulated.

5. We do not yet know what the pathology of her subsequent ileus was.

She finally died in another hospital of a "streptococcus sore throat."

CASE II.—*Resembling appendicitis—no operation—increasing calcification at nine years.*

P. H., No. 55256, schoolgirl, aged eight years, the daughter of a doctor, besides an occasional stomachache, very slight digestive disturbance and hay fever, had been a well child. Her bowels usually moved every day. On the morning before admission in October, 1922, they had not moved. This day she ate one apple in the morning and three the same afternoon. She was running hard, playing tag, when she began to have colic. That evening she had no alarming focal symptoms and was given a dose of calomel. The next morning she vomited. She had no temperature; her leucocytes were 8,000, but



there was tenderness in the right lower quadrant. She was brought to the Hospital from the country for observation. Her leucocytes on admission were first, 10,400, seventy-five per cent. polymorphs, a few hours later 8,800, seventy-two per cent. polymorphs, then 7,200 and seventy-two per cent. polymorphs on the following day. She was somewhat less well nourished and thinner than the average child of her age. There was definite tenderness above and internal to McBurney's point. She was sent for X-ray on the chance that she might have calcified lymph nodes. A single definite shadow was found to the right of the fifth lumbar vertebra. Her pain and tenderness soon disappeared. She was not operated on. She has been free from further attacks, violent activity having been somewhat lessened and definite attention being paid to increasing her nutrition, cod liver oil, etc. The following year a second X-ray film showed another area of calcification just below the first. The first seemed more thoroughly calcified. She also has calcified glands in the hilus region of both lungs.

N. B.—1. Acute symptoms accompanying dietary and physical stress when bowels had not moved.

2. No fever and no sustained leucocytosis.

3. Tenderness was above and inside McBurney's point, not at it.

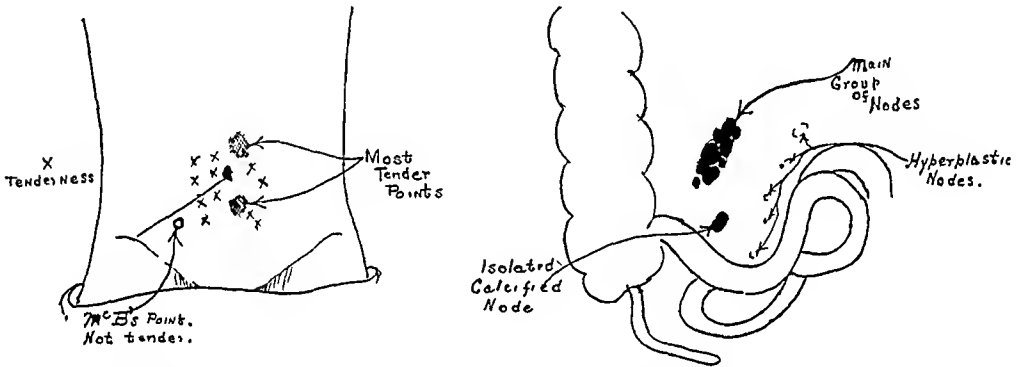
4. No operation was done and for seven years she has not had acute appendicitis.

5. One feels distinctly uneasy about not operating on such cases. They require almost too great discrimination to make it safe not to, and in general it is probably wiser to operate. There were other factors in this case such as her hay fever, a few

sonorous sounds in her lungs, and the fact that she was under her doctor father's close supervision.

CASE III.—*Mistaken appendicitis diagnosis. Calcification occurring between ages of eighteen to twenty-three years.*

P. H., No. 71319, female, single, aged twenty-three, university student. Severe measles with pneumonia at six years. When twenty-one years old severe grippe with marked prostration and swollen neck glands. Tonsillectomy soon after. When twenty-two, began having backache and pain in her right lower quadrant. Pain improved in summer, worse in winter, and was more marked with stress and strain. Abdominal tenderness just above and below umbilicus. In 1923 she was thought to have mesenteric node tuberculosis and sent for X-ray. No calcified areas were found. In 1928 she was considered by two careful and excellent physicians, one a surgeon, to have appendicitis while at college, though she had no increase in her leucocytes nor fever. May 2, 1928, she was X-rayed a second time, four and one-half years after her previous films. Both films, four and one-half years apart, were taken in Dr. Ross Golden's department and read by him. In the later films he found "irregular shadows just above the right ilium and within 3-4 centimetres of the spine, which have the characteristic appearance of calcified nodes."



At operation, May 2, 1928, the appendix was found to be perfectly normal, free, with no constriction, fecoliths, nor evidences of disease at pathological examination. Above the ileocaecal angle was a group of four or five calcified nodes and another isolated calcified node a few centimetres away. There were hyperplastic glands in the neighborhood. Appendix and glands removed. Active tubercles were not found in the nodes and the injected guinea pig did not show tubercle bacilli.

Noteworthy features: 1. A case where tuberculous mesenteric nodes was diagnosed four years before X-ray films showed calcification.

2. Calcification occurring between the ages of eighteen and twenty-three. Calcification occurs frequently in young children. In this instance it had not occurred at eighteen.

3. The appendix was found indisputably normal in spite of the diagnoses to the contrary before operation.

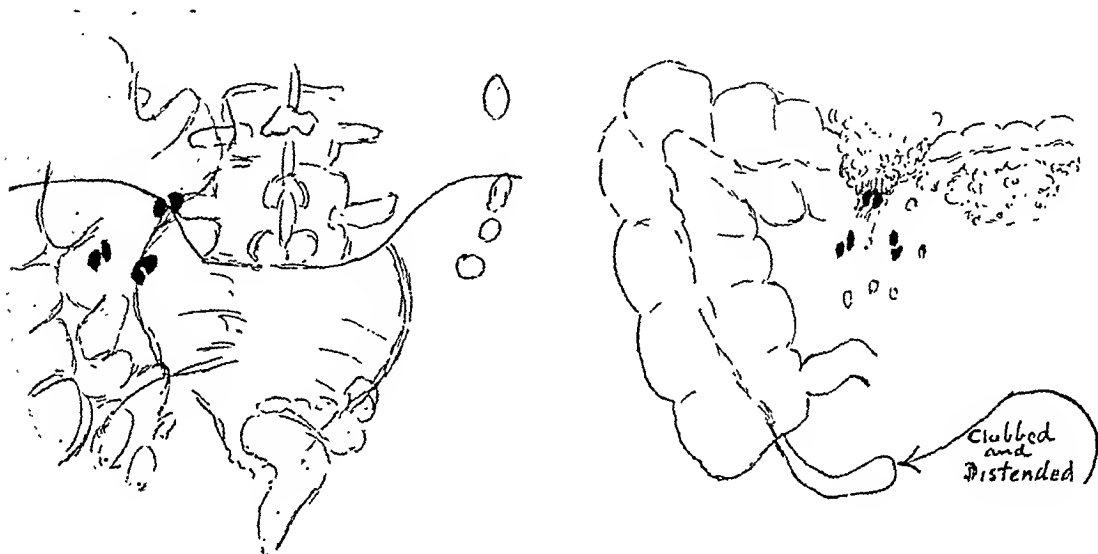
4. If appendectomy alone had been done in this case, it is more than likely that her symptoms would have persisted.

CASE IV.—*Symptoms due to adhesions to calcified nodes.*

P. H., No. 54290, female, single, aged twenty-two years. Scarlet fever and measles in childhood. Frequent attacks of right lower quadrant pain for a year, radiating to back and pubis, worse with running and other forms of exercise and stretching out at full length in bed, but better with rest, flexing thighs and heat. Leucocytes 5,900, polymorphs forty-nine per cent. On admission June 5, 1922, constipation, appendicitis, tuberculous peritonitis and ureteral callus were diagnoses made. X-ray of her abdomen showed several calcified node shadows. No operation was done at the time, but ten days later she had to return because of the severity of her pain.

## CALCIFIED NODES IN THE MESENTERY

At operation the appendix was found clubbed and distended. The first part of the transverse colon was rolled over on its long axis and tightly adherent to one of the groups of calcified nodes causing dilatation of the right colon and appendix. The ileo-cæcal valve was competent. There were too many nodes for removal and the cause of her symptoms was very evident. The appendix was removed and colon freed by sharp dissection and carefully peritonealized. Within six months she gained twenty-eight pounds following intensive rest and nutritional treatment. It is now seven years since operation and she is well, though she still has discomfort with stress or strain.



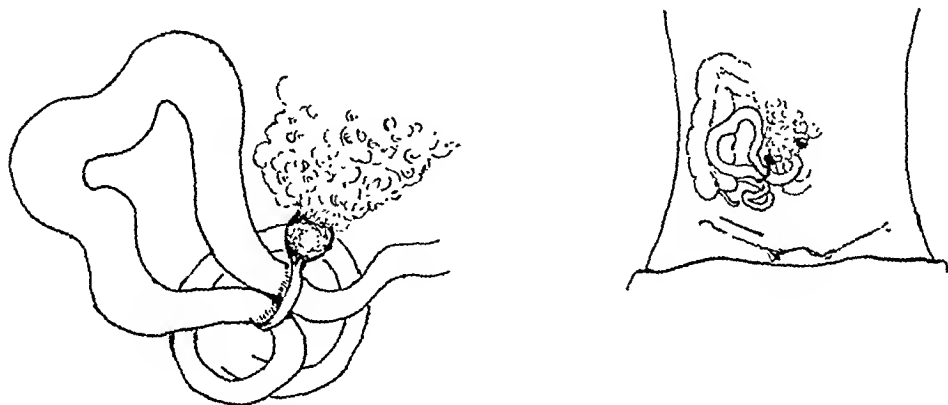
N.B.—1. A case where adhesions to calcified nodes gave the symptoms.

2. Dilated appendix due to colon obstruction is not rare and may resemble appendicitis, even predispose toward it.

3. Nodes left in. Occasional but no severe symptoms in past seven years.

CASE V.—*Ilcus from peritoneal band.*

P. H., No. 31243, housewife, married, aged thirty-one years, born in Denmark. Eight years ago operated upon elsewhere for right and left inguinal hernia. Right side



recurred in four years. Three weeks before admission, pain in right side attributed to recurrent hernia. When the hernia was reduced, the pain lessened or disappeared. This pain, however, really did not exist in the inguinal region, but was in the right lower quadrant, where it was associated with tenderness, slightly above and internal to McBurney's point. It was considered possible beforehand that she might be having mild attacks of appendicitis, and that the appendix at times might be descending into the hernial sac. At operation an inguinal incision was made to repair the hernia. The appendix was found to be atrophic, removed, but probably had nothing to do with her



symptoms. Just before ligating the sac, a finger, introduced to explore the pelvis, felt a hard mass like a marble just above the brim on the right side. This mass was pulled into the hernial wound. The omentum was found adherent to a calcified node measuring about 3 centimetres in diameter. From this node a peritoneal band passed across a loop of small intestine to the mesentery of another loop of small intestine, in such a manner as to partially constrict the first loop. There seemed but little doubt but that this was accounting for her symptoms. The band was divided, the omentum freed, the node removed, the hernia repaired, and as soon as she was able to talk after coming out of the anæsthetic, she volunteered the information that the old pain was gone. Six months later, she had gained 16 pounds, her bowels were quite regular. One year and seven months later there were no complaints.

1. A suspicion that the pain was not due to the obvious hernia was substantiated.

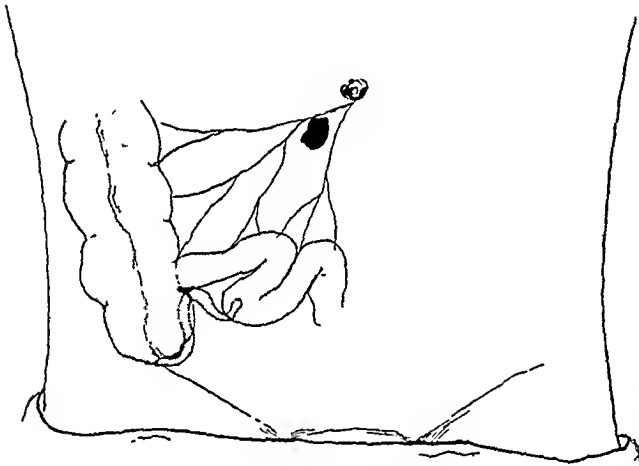
2. The pain was probably associated with (1) attachment of the band to the posterior parietal peritoneum, (2) chronic ileus due to incarcerated loop of small gut, rather than appendix, yet there was less pain when the hernia was not down. Whether a descent of small gut aboral to the incarcerated loop might have affected the tension in the latter, is open for conjecture.

3. It was a most fortuitous finding. Undoubtedly, the node would have shown,

however, had an X-ray been taken before operation, but it is doubtful whether the band could have been diagnosed before operation.

CASE VI.—*Appendix with fæcoliths. Tubercle bacilli found by guinea-pig infection.*

P. H., No. 70419, girl, single, aged seventeen years, university student. A healthful childhood except that in 1918 during the severe influenza epidemic she was very ill with it. In November, 1927, having once previously had a rather similar



attack, she awoke one morning with pain in her right lower quadrant. For over two weeks, this pain kept up, on and off, and she fluctuated between bed in her school infirmary and bed at home. She developed an acute bronchitis. Her highest temperature was 100°. An X-ray showed a calcified node overlying the right margin of the fifth lumbar vertebra.

At operation, December 5, 1927, the appendix was found to contain some fæcoliths, and removed. A partially calcified node, full of cheesy material, was excised from near the base of the mesentery along the ileocaecal vessels. There were no other evidences of tuberculosis elsewhere.

A guinea-pig was injected with material from the node. Acid-fast bacilli were found in the smears taken from its mesenteric gland.

In spite of the fact that the node was proven to be tuberculous, no tubercles nor giant cells could be found in pathological sections made of the patient's node.

The appendix showed no evidence of acute inflammation nor was it tuberculous. The noteworthy features in this case are:

1. The severity of her influenza illness in 1918.
2. Her appendix was a constipated one and probably giving symptoms.
3. The calcified node contained living tubercle bacilli.

CASE VII.—*Left side symptoms.*

P. H., No. 41156, female, single, housework, aged twenty-six years. Perfectly

## CALCIFIED NODES IN THE MESENTERY

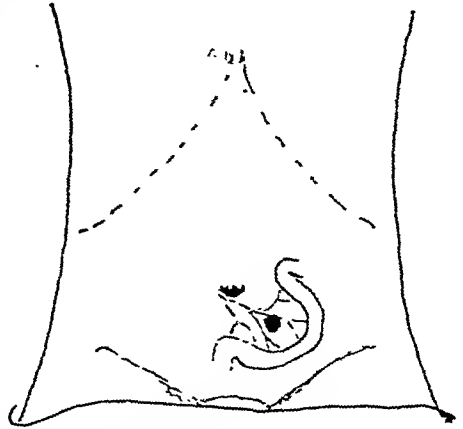
well up to one week before admission, when she awoke with a nagging, boring pain in the left lower quadrant, with no radiation. This has persisted several hours every day since onset. It was keeping her from work. An X-ray taken by her physician showed a very marked and definite characteristic calcified area to the left of the midline.

At operation, April 12, 1919, the appendix thought practically normal, but removed. The nodes which formed a very definite hard mass were removed. They were in the mesentery just to the left of the midline. Material from them was injected into guinea pig with negative result. She was quite relieved of her pain, and after a somewhat prolonged recovery, due to a hæmatoma in the operation wound, she was discharged in good condition, and remained well when seen several months afterwards.

1. The pain and tenderness, in this case, corresponded to the site of the nodes, on the left side. The pain was of acute character and persisted a week before operation. It entirely disappeared on their removal. There were no adhesions nor other mechanism demonstrable accounting for the pain.

2. The simple presence of the nodes, associated with some exciting mechanism, acting like a hair trigger, was all that could be found to account for her symptoms. The only thing done was to remove the nodes and a normal appendix, yet she was quite relieved.

The above are but a few typical examples of between one and two hundred cases of calcified mesenteric nodes that have been carefully studied during the past thirteen years.



# THE INJECTION TREATMENT OF VARICOSE VEINS \*

BY GRANT P. PENNOYER, M.D.

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FROM THE SURGICAL CLINICS OF ROOSEVELT HOSPITAL

THE varicose veins under discussion are those abnormally dilated, superficial veins of the lower extremity. These and conditions resulting from them are a frequent cause of disability in adult life, and any advance in their treatment is important.

The two saphenous systems are the most common to be involved. The great saphenous vein begins on the dorsum of the foot, passes just anterior to the medial malleolus, up the whole length of the medial aspect of the lower extremity to the fossa ovalis. The short saphenous vein passes behind the external malleolus up the posterior aspect of the calf to the popliteal space. These vessels may be multiple and are simply the main trunks of an elaborate network of superficial veins resting in the superficial fascia. It is easier, therefore, to refer to these veins as the greater and lesser saphenous systems. Most of the varices fall into one of these two groups. There are numerous communicating veins between these and the deep veins, especially below the knee. All these vessels are normally supplied with valves composed of single or double cusps, preventing the reverse flow of blood from the hydrostatic pressure in the erect position. Trendelenburg apparently was the first man to emphasize the backward flow of blood in varicose veins. The reflux of venous blood in these large varices without valves is apparently the underlying cause of the deficiency in the nutrition of the involved extremity. If the valves in the communicating veins are also incompetent, as is frequently the case, a vicious circle in the venous circulation is established. Blood escapes from the deep veins through the communicating to the superficial varices. Here, instead of passing upward, it again goes peripherally to be returned to the deep veins to continue the same cycle. It is obvious that this would deprive the superficial tissues of almost all normal circulation and nutrition. Obliteration of the varices breaks the cycle, and immensely improves the circulatory situation. Doctor McPheeters of Minneapolis has recently done some very interesting work on this reverse circulation by observing under the fluoroscope the course of intravenous lipiodol injections. There is no doubt that this is the situation behind many varicose ulcers, and explains the striking benefit often obtained by chemical sclerosis of the neighboring varices. A valuable advantage of this treatment is that one does not hesitate to inject a vein near an ulcer, while excision in such a field would be unwise.

The deeper veins have the support of the muscles. Without some complicating pathology such as phlebitis, back pressure from above, and so forth,

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\* Read before the Surgical Section of the New York Academy of Medicine, October 4, 1929.

## THE INJECTION TREATMENT OF VARICOSE VEINS

they are rarely involved in the varicose condition of the superficial veins, which have no support. The compression effect of the muscular contractions on the deep veins with competent valves forces the blood towards the heart. This has been demonstrated to be one of the most important factors in the venous circulation of the lower leg, and, of course, is absent in the superficial veins.

The injection treatment of varices seems to date back to the invention of the hypodermic syringe in 1851 by Doctor Pravaz of Lyon. He and rather numerous subsequent workers did considerable work along this line, using strong coagulating and corrosive solutions, such as ferric chloride, iodotannic acid, alcohol and phenol. These solutions which coagulated the blood were early recognized as dangerous, and the treatment was never prevalent or accepted. Sixty years later, in 1911, Professor Linser, of the Tübingen Skin Clinic, noticed the 1 per cent. solution of bichloride of mercury injected in syphilitic patients frequently resulted in firm obliteration of the veins used. He used this solution to sclerose varices with considerable success, and despite its toxic effects, it is still used by a few. Professor Sicard of Paris about the same time used an aqueous solution of sodium salicylate with ideal results, and his work has done more to popularize the treatment than that of any other one man. In 1928 he published a series of 325,000 injections without a single pulmonary infarction. Within the last few years, the chemical obliteration of varices has been taken up by a great many men scattered all over Europe and this country. Its safety and value are now well established.

Numerous solutions have been introduced and which one is ideal is still disputed. Since 1923, 20 per cent. sodium chloride aqueous solution is used in the Tübingen Clinic instead of the original toxic mercuric bichloride solution. Concentrated sugar solutions are effective and popular. Doctor Genevrier in 1921 introduced a now extensively used mixture of solutions of the hydrochloride of quinine and urethane. We have used for almost all our work a 30 per cent. aqueous solution of sodium salicylate, which is made up and sterilized in ampules in the chemical laboratory of the Roosevelt Hospital. Our experience with the other popular solutions has not been sufficient to allow an authoritative discussion of their relative merits. We have been quite satisfied with our results from sodium salicylate. A 5 c.c. injection of 30 per cent. sodium salicylate almost never fails to give a good firm sclerosis of the vein for a very considerable distance even in large varices, and it is our impression that more can be accomplished in fewer injections with this solution than with any other. The obliteration of the vein is rapid, positive, firm and permanent. It has the distinct disadvantage of causing a severe cramp shortly after its injection, which lasts about one minute. Like most of the other solutions, it will cause a slough of tissue if it gets outside the vein in any considerable amount. Quinine and urethane solutions have the advantage of causing no pain following injection. Doctors Kern and Angle of the Johns Hopkins Clinic consider a mixture of equal parts of 50 per cent. glucose and 30 per cent. sodium chloride the ideal solution, because it will

not cause a slough if it gets into the tissues, but we have seen sloughs result from this mixture. None of these solutions coagulate the blood, but depend for their action on an irritative and destructive action on the intima of the veins.

Considerable study has been made of the pathology shown by sections of the veins excised at various intervals following injection treatment. The irritating solution causes a necrosis of the intima. A fibrin deposit, inflammatory cells, and blood clot obliterate the vein lumen in two to four days. A growth of fibroblasts into the fibrin and clot firmly organize it and eventually the vein is converted into a fibrous cord, almost nothing of the original vein structure remaining. The entire process requires several weeks.

Careful comparative studies have been made of the surgical excision and injection treatment of varices. Doctor McPheeters of Minneapolis and Doctor Kilbourne of Los Angeles have recently published extensive statistics, their information being obtained from the literature and questionnaires sent out to many clinics and surgeons. Doctor Kilbourne reported one death from embolism in every 250 cases operated upon, in a series of 4,607 cases. Doctor McPheeters reported almost the same proportion of fatal pulmonary emboli in 6,771 operated cases, and claimed other complications such as pneumonia, brought the operative mortality almost to 1 per cent. Only four authentic cases of pulmonary emboli have been found in injected cases, and almost 400,000 injections have been reported in the literature. Probably all of these four occurred in cases where the injection was done in the presence of a thrombophlebitis, the existence of which is a definite contra-indication to the injection treatment.

The results of the chemical treatment are better. Doctor Kilbourne reports 30 per cent. unsatisfactory results in his reported operated cases and Doctor McPheeters about 20 per cent. Charges have been made that the injection treatment does not give a permanent sclerosis, but this has not been our experience. We have seen only four definite recurrences in our cases followed up to eighteen months. Doctor Kilbourne finds the recurrences in injected cases 6 per cent. New varices occur more often than this, but these are not recurrences of the old varices, and simply mean the underlying cause of the condition is still present. As they occur, it is a very simple matter to inject them, while a second operation is quite a different consideration. The injection treatment is, therefore, safer and gives better results than the surgical excision. No disability is involved in the chemical treatment. The patients continue with their regular work immediately as contrasted to hospital confinement for an average of 15.1 days and an average disability of 34.8 days. No anæsthesia is required, no scars result, the discomfort is less, and the relative cost is smaller.

The details of the technic we have used in our cases are extremely simple, and no special equipment is required. The same needles used to administer salvarsan are employed. They should be sharp and have a rather short bevel. A long bevel on the point predisposes to some leakage of the fluid into the tissues. The ampules of 30 per cent. sodium salicylate solution, a 10 c.c.

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glass luer syringe and rubber tubing tourniquets complete the equipment. The site of injection is selected with some care. One must remember that if the leg is dependent, the blood current is reversed, and much of the sclerosis will be below the site of injection. We begin with the lowest varices. Usually at least six to eight inches of obliteration results from each injection of 5 c.c. of solution. If a group of varices involve the entire length of the lower leg, the first injection would be placed about midway between the knee and the ankle. The position of subsequent injections depends upon the results of this first. We have been giving only one injection at one treatment, and waiting to see its full effect before giving the next one. This usually requires almost a week, and it does no harm to wait much longer. Done in this way, rarely more than three or four injections are required to treat completely an extremely involved extremity.

The patient sits on the side of an examining table with the legs hanging over, and a tourniquet is placed loosely above the varices to make them distend further, and the solution is injected into them in the same manner as any intravenous medication is administered. To insure the needle is squarely in the lumen of the vein, it is a good plan to let a little blood flow back into the syringe several times during the injection. The salicylate solution does not coagulate it, and it does no harm to inject the mixture. While and after the needle is withdrawn, firm pressure is maintained at the site of injection to insure against leakage. In a few seconds, a severe cramp occurs, and its location gives some clue as to the diffusion of the sclerosing fluid. With the legs hanging over a table and a tourniquet above the varices, it is usually mostly below the injection point. As soon as the cramp sets in, we remove the tourniquet and allow the patient to lie down on the table. The cramp only lasts about a minute, and no further discomfort is felt by the patient except more or less soreness in the treated vessel until the process is complete. A firm bandage is applied to keep the veins collapsed and should be worn continually until the veins are well obliterated. This is an important point. If the veins are kept quite empty it is frequently difficult later to tell where they were, but if they are allowed to thrombose in the distended condition, they become hard, tortuous, tender swellings which feel like the veins of an infectious thrombophlebitis, and may be troublesome for a considerable period of time. Such a vein may be obliterated from the circulation, but it may be difficult for a time to persuade the patient they have not been made worse by the treatment. Eventually these cases get a good result, but it takes much longer than in those cases where the veins were kept collapsed in the early stages of the process.

The less blood in the vein at the time of injection, the more concentrated and thorough will be the application of the medication to the intima. For this reason, some have attempted to inject them in a collapsed condition. This can be accomplished by having the patient flat, and using tourniquets loosely applied a little above and below the varix under treatment. The needle is inserted with the vein distended. An assistant then evacuates the veins by pressure or elevation of the leg and applies the tourniquets before the injection

is made. Except in very large varices, this is not necessary, and it is much easier to get some leakage of salicylate solution when working with collapsed veins. Occasionally one encounters extremely large varices which are almost like blood sacs, and it is necessary to follow the above technic to get a good result.

The patient, after being bandaged, can resume his or her regular duties without restrictions. They complain of soreness in the treated veins, but no other disability.

We have treated up to date 218 patients, and have given about 500 injections in 306 legs. Forty-eight of these cases we have been able to follow more than a year, and in all these the sclerosis has been so far permanent and satisfactory. All the other cases were injected less than a year ago, or have been lost. Some have returned with new varices. This is hardly an indictment of the treatment, as it means simply that the original predisposing factors to varices are still present, and no one claims the treatment influences these factors. It is a simple matter to inject these new varices, as they are usually only one or two small groups after the main trunks have been removed. I have seen a small number of veins recanalize, nearly all in cases of large varices not well bandaged after treatment, so thrombosis occurred in the distended condition. These were all early cases in the series, and re-injection has given a good result.

Like all treatments, it has limitations and contraindications. It will accomplish easier and better than surgery the removal from the circulation of any superficial vein which we may wish to remove. The end result, as far as the circulation is concerned, is the same as surgical excision, and the procedure is so simple that it can be done with safety in all sorts of cases in which surgery would be undesirable. There are very few factors to be considered except what is to be accomplished by removing the veins in question. Age, general debility, infected ulcers, and so forth, contrasted to surgery, are not contraindications. It is universally agreed it should not be done in the presence of any infectious thrombophlebitis, new or old. The extremely rare reported instances of infarction occur in these cases. Large veins in such cases are frequently compensatory dilatation of the veins instead of true varices. In treating ulcers, it is always to be remembered that many other causes besides the varices are frequently present. Arterial disease, diabetes, syphilis, and so forth, are sometimes factors and they all should be considered before injecting, although none of these conditions are contraindications. Don't expect too much from simple obliteration of varices, if such complications are present. Extremities with chronic elephantiasis and hard, brawny œdema associated with deep extensive ulcers, frequently of years' standing, are little benefited by injection treatment. It is usually hard to find the varices in the thickened œdematous tissue. Sometimes considerable can be done with these cases by putting them to bed for a week to reduce the œdema before injecting, but they will rarely consent to this.

We have not done any work with very small varices. They are not large

## THE INJECTION TREATMENT OF VARICOSE VEINS

enough to be of importance in the circulation. With the use of sheer stockings and short skirts, there is demand for the removal of these small superficial dilated veins for cosmetic reasons, and I do not see why this is not justified. In injecting sodium salicylate solution into veins which are so superficial that they are practically in the skin, there is a tendency for the resulting chemical phlebitis to involve the skin causing small eschared spots which develop into small ulcers which heal rather slowly. Less caustic solutions, such as the sugar and salt ones, are more desirable in this type of case.

We have done very little injecting much above the knee, although many of the men who have had considerable experience, do not hesitate to do so right up to the saphenous opening. Undoubtedly the pressure of extensive varices left above the knee, predisposes to the occurrence of new ones below the knee, but those above the knee do not cause the circulatory disturbances in the leg which are so common in the cases lower down.

Our only complications in the 218 cases have been ulcers, all of which result from faulty technic. I have found only six of these, and four of them were very small and resulted from treating veins which are practically in the skin. Small saccular dilatations in the veins which project almost through the skin, will sometimes give small ulcers even though there is no leakage of salicylate solution. Less necrosing solutions would avoid this difficulty.

The results in ulcer and eczema cases are very encouraging, sometimes dramatic, but not universal. In many so-called varicose ulcers, it is difficult to find the offending varices, and consequently impossible to accomplish much by injecting. When there are large varices present and there is no other complicating pathology behind the condition, the result of obliteration of the varices is sometimes striking. In our series, there are twenty-six cases with long-standing indolent ulcers, who have had prompt healing following the treatment, and have remained healed.

### CONCLUSIONS

Varicose veins of the lower extremity can be permanently obliterated by the injection method.

The method is safer and easier than the surgical excision, and has numerous other advantages making it preferable to the operative treatment.

The technique is simple, and no hospital confinement is required.

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# THE CONTINUOUS INTRAVENOUS ADMINISTRATION OF PHYSIOLOGICAL SALT SOLUTION\*

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THE administration of physiological salt solution by way of the veins

has become one of our most valued methods of treatment. When it is necessary to give it in very large quantities, however, or over a period of several days, the necessity for introducing the needle for each administration constitutes, for children particularly, a very serious difficulty. The method herein described is an attempt to overcome this difficulty.

The apparatus is depicted in Fig. 1 with sufficient clearness to render little description necessary. It consists of a graduated reservoir of pyrex glass, fine rubber tubing, a glass capsule, and a fine gold cannula. The pyrex reservoirs are of 2000 c.c. and 4000 c.c. capacity in order to avoid the necessity of frequent changing. It is necessary that they be

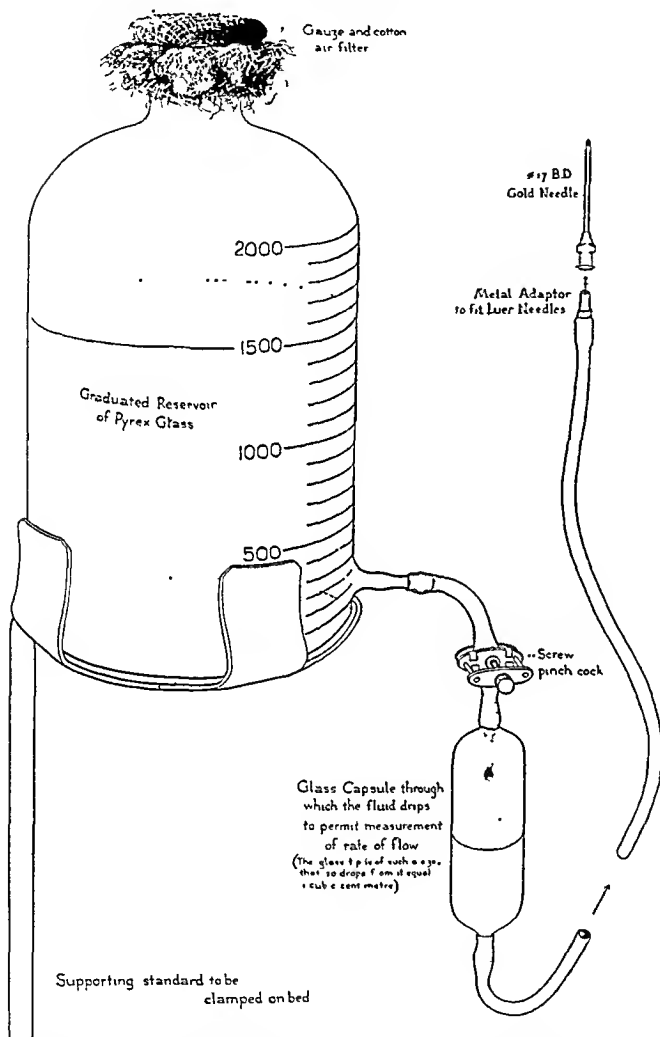


FIG. 1.—The reservoir is made of pyrex glass in order to withstand the temperature of the autoclave in sterilization. The neck is capped with a gauze and cotton pad tied on. This is not removed as long as the flask is in use. When one flask is emptied it is replaced by a freshly sterilized full one. An outlet tube is fused to the side of the flask low down. To this the rubber tubing is attached. The screw cock permits regulation of the rate of flow. The glass capsule through which the fluid drips permits estimation of the rate of flow at any particular moment, since the tip of the cannula in the capsule is of such a size that 20 drops from it equal 1 c.c.

From an opening low down in the side of the reservoir the fluid passes through rubber tubing to a glass capsule. It drops through this capsule from a glass pipette of such a size that twenty

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## INTRAVENOUS ADMINISTRATION OF SALT SOLUTION

of the drops falling from it constitute one cubic centimetre. Counting the drops per minute, therefore, renders easy the calculation of the rate of flow at any moment. The rate of flow is regulated by a screw pinch cock. We have found by experience that as small a flow of 500 c.c. per day may be maintained, and of course any rate greater than this.

Before use the apparatus is filled with salt solution and sterilized in the autoclave. The cannula (a No. 17 Becton Dickinson gold needle) is introduced into a superficial vein on the dorsum of the hand or foot (Fig. 2) through a small incision made under local anæsthesia. It is tied in with catgut. If the hand is used, it is well to fix the hand in relation to the



FIG. 2.—This photograph shows the apparatus in use upon a patient suffering from intestinal obstruction following appendicitis. For more accurate delineation of details the dressings have been removed from the hand.

forearm by means of a light anterior splint of plaster or cardboard. This permits the patient to shift the whole arm without endangering the position of the needle. The vein should be small, just large enough to accommodate the needle—since the smaller the vein the faster will be the rate of flow through it for any given rate of administration. This minimizes the danger of clotting. A steady flow should be maintained. Intermittent flow favors clotting in the cannula, while a steady flow fills the vein with saline and prevents clotting.

There are a few points of importance, attention to which will facilitate the use of the apparatus. It is best not to use glucose solutions in this apparatus. This substance, in concentrated solutions, when injected into veins, produces thrombosis with such readiness as to make it one of the most useful of the chemicals used in the injection treatment of varicose veins. Even in the

more dilute solutions (5 per cent. and 10 per cent.), which are so frequently used as intravenous medicaments, prolonged use will also occasionally result in thrombosis. As a routine, therefore, glucose solutions should not be given. If it is considered necessary to administer glucose with this apparatus, the required amount should be given rapidly and should be followed by physiological salt solution. Physiological salt solution or Locke's solution are the most satisfactory fluids for use in this apparatus. (Locke's solution consists of sodium chloride 0.9 per cent., calcium chloride 0.024 per cent., potassium chloride 0.042 per cent. and sodium bicarbonate 0.01 per cent. to 0.03 per cent. It contains all the saline constituents of mammalian blood in their proper proportions.)

No attempt is made to heat the fluid before it enters the vein. To be effective, the heat would require to be applied to the fluid immediately before it entered the vein, since the rate of flow of the fluid is so slow that were heat applied at the reservoir much of it would be dissipated before the fluid entered the vein. To add to the apparatus an appliance for maintaining the fluid at body temperature would add greatly to its complexity. In our opinion, it is simpler to heat the patient by means of hot water bottles than it is to heat the fluid. As a matter of experience, we have found that the administration of fluid at room temperature by this method gives rise to no more disturbance than does the administration of fluid of similar temperature by mouth.

Clotting in the cannula or vein gives surprisingly little trouble if a few simple precautions are taken. As previously mentioned, the vein should be as small as will accommodate the needle in order to ensure as rapid a flow as possible. There should be no cessation in the flow of fluid as this permits blood to regurgitate into the cannula and clot there. It is often useful to permit the fluid to run rapidly for a few minutes to ensure a free channel. If the cannula does become plugged in spite of these precautions, it must be reinserted into another vein.

The use of this apparatus has permitted us to administer large amounts of salt solution over long periods of time. The longest period of continuous use without changing the cannula has been ten days. Continuous administration for two, three or four days has frequently been carried out. The rate of flow may be as low as 500 c.c. per day without clotting.

DISCUSSION.—DR. J. SHELTON HORSLEY, of Richmond, Va., said that about eight or nine years ago Doctor Matas, of New Orleans, in a paper published in the *ANNALS OF SURGERY*, explained at considerable length a technic that he had been using for the continuous intravenous injection of glucose solution. He used a technic somewhat similar to the so-called Murphy drip in which the rate of dropping could be visualized.

For the last five years the speaker had used Ringer's solution to which 5 per cent. glucose (dextrose) was added. In order to avoid the possibility of air getting into the vein, which of course would be quite a serious com-

## INTRAVENOUS ADMINISTRATION OF SALT SOLUTION

plication in the drip method, he was using a long, narrow burette that will hold 500 cubic centimetres of fluid. It is graduated in such a way that the flow can be regulated rather accurately because 100 cubic centimetres covers a graduation distance of 9.2 centimetres. The nurse can tell fairly accurately the rate of flow merely by watching the level of the fluid, and can regulate it with a little screw clamp.

In patients that do not appear to be very sick and where the vein is readily accessible a hypodermic needle can be used, but when the flow is to continue for one or two days we use a cannula and tie it in the vein. In one case he had given as much as 40,000 cubic centimetres. He often gives it for two or three days continuously at the rate of 100 to 200 cubic centimetres per hour. After about two days it begins to irritate the vein, when it is best to take it out, wait for about a day and if necessary insert it again in another vein.

If a solution of glucose or dextrose no stronger than 5 per cent. is injected the vein is not greatly irritated until after it has been used two or three days. The blood normally contains glucose. However, the stronger solutions do tend to irritate the vein.

There are one or two rather important points. The water should be freshly distilled; the tablets for Ringer's solution are added to the dextrose just before it is used. Sometimes he has found a reaction if he has used dextrose that comes in bulk, but there is practically no reaction when the dextrose available in ampoules is employed. By injecting into the tube some insulin at intervals the dextrose is activated and its assimilation is helped. Much nourishment can be given by this method and the normal salts of the blood serum are supplied.

DR. ALEXIS CARREL, of New York City, remarked that during the war a smaller apparatus was made for the continuous injection of fluid under the skin or into the vein. This apparatus was constructed along jejunal lines and its great advantage is its extreme simplicity. All one needs is a tube, a needle, and any kind of container for the fluid.

The apparatus consists of a small electric motor which drives a little wheel at the periphery of which there are about six rollers. The tube is placed against a spring and as the little wheel revolves it presses upon the tube. Knowing the number of revolutions, one knows the amount of fluid being injected. It can be regulated to the speed desired.

As nobody was interested in this subject twelve years ago, they manufactured only one apparatus, but it has worked very well. If this method were to be put into general use, it would be very simple to have the little wheel with the motor manufactured in large amounts.

DR. DEAN LEWIS, of Baltimore, Md., remarked upon the value of intravenous salt in many lesions. Recently he had a patient with ulcerative colitis. An ileostomy was performed. On several occasions he lost salt rapidly, the blood salt dropping to 286. When the salt was this low the temperature would fall to 96, the patient would become cyanotic and cold.

One of Doctor Horsley's former house officers is on the staff and they gave, as suggested by him, continuous salt intravenously for days. They gave a hypertonic salt solution and Ringer's solution with glucose. The prompt reaction of this patient to intravenous salt given continuously was most striking. The cannula in the vein causes no great discomfort.

PRESIDENT ELIOT asked Doctor Gallie in closing the discussion to touch upon the question of enterostomy, whether in cases in which the treatment was adopted enterostomy was never practised, or whether the treatment was a last resort, and if the treatment failed to secure a renewal of the peristalsis after twenty-four or thirty-six hours enterostomy was then practised. As Doctor McArthur has said, it has proven a life-saving measure in a good many instances, especially where there is not too much delay.

DR. W. EDWARD GALLIE (in closing the discussion) remarked first, for those who have not used the method described in his paper there is one point in the introduction of the cannula which is important. It is wise to choose a small vein, a vein about the same size as the cannula. In that way one avoids having the point of the cannula running around in the vein and injuring it, and it also avoids a backwash.

In fastening the cannula it is rather important, particularly in small children, to devise a method that will allow the patient to move his arm about without taking any risk of dislodging the needle or cannula. He usually made a plaster splint so as to hold the hand in a fixed position, then introduced the cannula into a small vein and then stuck the cannula down with a piece of adhesive plaster. Such an arrangement allows the patient to move the arm about fairly freely and does away with the risk of dislodging the cannula.

Occasionally some patients complain of discomfort in the vein if the fluid is cold. That is not frequent but sometimes does occur. That difficulty can be overcome by putting a hot water bottle on the tube, in the neighborhood of the patient's arm, as it comes to the vein.

Glucose, in his experience, is rather dangerous. That is, it may cause an extensive thrombosis in the vein. It doesn't always do so but it does occasionally.

With regard to his experience with jejunostomy in ileus of children following appendicitis—that is the inflammatory type of ileus—he had used the method a good many times but with no enthusiasm and without any good results. His experience has been that in practically every instance in which he has introduced a tube into the jejunum in this type of ileus nothing ever came out of the tube.

# TRANSACTIONS

OF THE

## PHILADELPHIA ACADEMY OF SURGERY

STATED MEETING HELD NOVEMBER 4, 1929

The President, DR. ASTLEY P. C. ASHHURST, in the Chair  
CALVIN M. SMYTH, JR., M.D., Recorder

### BLEEDING ŒSOPHAGEAL VARICES, DUE TO HEPATIC CIRRHOSIS

DR. RALPH GOLDSMITH, by invitation, reported the case of a printer, aged fifty-six years, who was admitted to the Jewish Hospital May 4, 1929, in the service of Dr. William H. Teller, to whom the speaker was indebted for the opportunity of operating upon him. The previous history was irrelevant except for the fact that he had been a heavy drinker for about thirty years. December 28, 1928, he had a sudden feeling of weakness and shortly afterward noticed that his stools were tarry. Occasionally thereafter he observed a little blood in his stools, but paid no attention to it. On the day of admission he hurried for a car and suddenly collapsed. He vomited a large quantity of bright blood and continued to do so after admission to the hospital. So profuse was the hæmorrhage that his hæmoglobin fell to 23 per cent., with a corresponding drop in erythrocytes, and his condition was so critical that it was impossible to carry out any gastro-intestinal studies. Physical examination revealed nothing that threw further light upon the case. There was no splenic enlargement. The test of hepatic function showed a normal dye retention. After repeated blood transfusions his hæmoglobin rose to 50 per cent. and operation was performed on May 25, 1929.

The abdominal cavity was entered through an upper right rectus incision. Examination of the stomach and duodenum failed to reveal evidence of any lesion. The stomach was not opened. The liver was definitely cirrhotic, the cirrhosis appearing to be a moderately severe Laennec's process. Additional corroborative evidence was found in that the veins in the gastrohepatic omentum and along the lesser curvature were dilated and unduly tortuous and that the same was true of the veins in the falciform ligament. Accordingly the gastrohepatic omentum was divided between ligatures from as close as possible to the cardia all the way to the pylorus. Its freed edge was then sutured to the anterior parietal peritoneum in the neighborhood of the incision. The operation was done with ease and was well borne by the patient.

Convalescence was entirely uneventful and the patient was discharged in good condition. He has been interrogated at intervals in the interim and has remained well. He was last interviewed on November 1, 1929. At this time he was found to have gained about fifteen pounds. He has been working steadily for several months. He has at no time experienced any discomfort referable to his gastro-intestinal tract, nor has he vomited blood nor passed it by bowel. There was no discernible ascites nor œdema of the legs or feet. He continues to use alcohol, though in moderation as compared with his past indulgences. He considers himself to be in excellent health. It has been impossible to arrange with him to submit to further investigation.

This case was presented with a full realization that the diagnosis of bleeding œsophageal varices was made inferentially rather than by direct evidence, but it is believed that it is as soundly established as is usually the case. It was also realized that the period which has elapsed since operation—five months—is insufficient upon which to base a presumption of permanent success. On the other hand, the rationale of the procedure as well as its apparent safety is such as to warrant the hope that it may be completely successful and to justify the further application of the method.

The reporter remarked that the majority of deaths in patients suffering from portal cirrhosis are undoubtedly caused by hæmorrhage, and the fatal hæmorrhage invariably results from the rupture of varices in the lower portion of the œsophagus. Treatment of this condition has always been unsatisfactory, although a certain number of cases have been benefited by operations of which the Talma-Morrison is the best known and most successful. Rowntree, in the proceedings of the Staff Meetings of the Mayo Clinic, vol. iv, No. 16, April 17, 1929, reported a new procedure in the management of this disease, and presented a case in which it had been utilized. Walters, in discussion, mentioned that it had been carried out in a second case. It is believed that the case herewith presented may be the third to be recorded.

The principle upon which the operation is based is that of preventing the blood dammed back by the portal obstruction from reaching the œsophageal varices. McIndoe, of the Mayo Clinic, injected and removed *en bloc* the portal system and the chief collaterals in some patients who had died of cirrhosis, and found that the bleeding point was practically always situated at the lower end of the œsophagus or just within the cardia. He found, also, that the varices invariably "lie between the coronary vein of the portal circulation on the one hand, and the intercostal and azygos minor veins of the caval system on the other. The coronary vein normally drains the lesser curvature of the stomach from pylorus to cardia, and then turns abruptly to the right within the gastrohepatic omentum to open into the portal vein proximal to its juncture with the splenic vein. Coincidentally with the development of the collateral circulation the flow of blood in this vein is reversed and the full force of the portal current is directed against the cardiac and œsophageal anastomotic venous plexus. A localized area of submucosal varicose veins is produced, which owing to its unprotected situation is particularly exposed to trauma."

The operation proposed by Rowntree on the basis of this mechanism described by McIndoe was successfully carried out in two cases by Waltman Walters (*loc. cit.*). It consists of interrupting the flow of blood from the coronary veins to the varices by ligating the former. This is accomplished by ligating and dividing the gastrohepatic omentum throughout its length, care being taken to go as close to the gastric cardia as possible. The divided edge of the gastrohepatic omentum is then sutured to the anterior parietal peritoneum, either incorporating it into the abdominal incision or anchoring it in the region of the falciform ligament of the liver, in the hope of estab-

lishing collateral circulation through the para-umbilical veins to the cava. Thus it is planned to increase the anastomotic routes as well as to prevent further hæmorrhage from the varices.

DR. DAMON B. PFEIFFER asked whether the condition of the spleen was noted at the time of operation. Several years ago in reviewing the literature of gastric hæmorrhage with special reference to the spleen as a cause, he was surprised to observe with what frequency hæmatemesis had been reported by surgeons of the highest qualifications who had nevertheless failed to mention in their reports whether the spleen had been examined at the time of operation or had in any way been considered as a possibility. He reported at that time two cases of massive gastric hæmorrhage due to splenomegaly and based on his observations in those cases made the suggestion, which so far as he can determine was original, that hæmorrhage in these cases is usually due to erosion of the submucous varices in the fundus of the stomach. In that obscure paper he called attention to the fact as stated by Mall that 40 per cent. of the blood in the splenic artery goes to the stomach, and that there is a corresponding venous return. Enlargement of the spleen with its immense demand for blood would probably result in a greater supply to the fundus of the stomach as well, and the well-known capacity of the spleen to contract under certain conditions would from time to time shut into the stomach even greater quantities of blood which would have been carried off by the veins. This would seem to be an efficient cause for the varicosities observed in the fundus. He noted, also, that the vasa brevia were obviously enlarged. He is calling attention to these points in order to induce surgeons, who make reports of operation upon cases of massive gastric hæmorrhage, to note and report also the size and condition of the spleen.

DR. I. S. RAVDIN said that Dr. T. Grier Miller, Dr. Harold Austin, and himself had been engaged in some experimental work on the relation of ligations of the splenic artery and vein to venous pressure in the gastro epiploic veins. They had evidence which indicated that when the splenic artery or vein were ligated at a point distal to where the blood from the stomach emptied into the splenic vein, that pressure rises in the gastro epiploic veins. The speaker suggested that in splenic disease where a condition of this sort might be stimulated within the spleen itself, the rise in pressure in the gastro epiploic veins might produce varices and that this rise in pressure might result in gastric hæmorrhage.

DR. HUBLEY R. OWEN called attention to a recent report of a case by Dr. Dewitt Stettin, of New York, in which he did remove the spleen. The interesting point of his case was the remarkable return of the blood picture to normal within a very short time. Recently the speaker discharged from the Woman's College Hospital a patrolman who had had two overwhelming gastric hæmorrhages while on duty. The diagnosis was bleeding gastric ulcer. However, it was impossible to operate at that time. He was readmitted to the hospital on September 1. He received practically no treatment



but four or five blood transfusions, after which paracentesis removed considerable fluid from his abdomen. Doctor Owen asked Doctor Goldsmith the blood picture of his patient when he operated. In the speaker's case the hæmoglobin was 40 per cent. with about 2,000,000 red cells.

DOCTOR GOLDSMITH reported that his man was thoroughly explored and his spleen was substantially normal in size, perhaps slightly enlarged. The veins along the lesser curvature of the stomach were enlarged. His liver did not show very marked change; none the less he had these violent hæmorrhages. The speaker had thought of having an examination with the œsophagoscope at some later date, but has been unable to arrange it. The blood picture was 30 or 35 per cent. hæmoglobin which was raised by transfusion until it was in the neighborhood of 50 per cent. The operation itself is extremely simple and was followed by little or no reaction.

#### SUBACUTE HÆMORRHAGIC PANCREATITIS

DR. RALPH GOLDSMITH reported the case of a man, aged forty-five years, who had always been in what he considered to be good health. For two years, however, he had been troubled at times by attacks of indigestion which took the form of a feeling of abdominal distention and discomfort. This he attributed to constipation and was able to obtain relief by enemata and carminatives. His appetite was always excellent and he was not particularly distressed by the taking of food. There was no loss of weight or strength. He was very nervous, and when agitated for any reason whatever was in the habit of vomiting. This vomiting sometimes occurred coincidentally with the attacks of indigestion, but was just as likely to happen independently of the latter.

In February, 1929, the patient, in order to ward off a cold, purged himself thoroughly. He was awakened that night by severe cramp-like abdominal pain accompanied by vomiting. He was treated by his physician and the pain wore off gradually, but he felt weak enough to remain at home for two or three days. X-ray examination on March 1, 1929, was reported as follows:

"Röntgenographic study of the abdomen made six and twenty-four hours following the inspection of an opaque meal reveals evidence of an abnormal spastic type of colon. Fluoroscopic examination shows evidence of a localized tenderness over the shadow of the contrast filled appendix. Cholecystography shows evidence of chronic gall-bladder disease. There is still retention of the contrast meal in the caput coli and appendix at forty-eight hours following the ingestion of the meal and still a well defined tenderness immediately over this area. There is undoubtedly röntgen evidence of chronic pathological changes about the appendix."

March 7, 1929, the patient was again awakened by an attack similar to the one described above. The pain was described as "crampy, knife-like and as though a belt were being pulled tightly around the abdomen". It was rather more intense than in the first attack, and was most marked in the right lower quadrant. It was again accompanied by vomiting and sweating, but no fever nor chills were noted. A hypodermic of morphine was administered with considerable relief. A diagnosis of appendicitis was made and on March 17, 1929, the patient was admitted to the Jewish Hospital.

The patient walked into the hospital. He made no complaints and appeared to be entirely comfortable. His temperature, pulse and respirations were normal. Blood pressure was 124/84. Physical examination revealed

## SUBACUTE HÆMORRHAGIC PANCREATITIS

diseased tonsils, a lipoma of the shoulder and a very obese abdomen with moderate tenderness of the right side, particularly in the lower quadrant. There was no rigidity, no masses were felt, peristalsis was active, and the matter of shifting dullness was not noted. Examination was otherwise negative. An electrocardiogram showed a simple tachycardia only. The urine was negative except for a trace of albumen. Examination of the blood revealed hæmoglobin 92 per cent., neutrophiles 75 per cent., erythrocytes 4,650,000; lymphocytes 25 per cent., leucocytes 9100. The Wassermann reaction was negative. Blood sugar was .091, blood urea nitrogen 13 milligrams. A diagnosis of chronic appendicitis and chronic cholecystitis was made and the patient operated upon on March 19, 1929. Upon opening the peritoneum there was a gush of creamy pinkish-white fluid containing recognizable globules of fat. So much of this escaped that it was impossible to measure it, but there must have been several pints. There was necrosis of the omental fat and of the appendices epiploica. The peritoneum was reddened and exhibited white fatty plaques. Exploration revealed a rather small, free appendix, not acutely inflamed. The gall-bladder was thickened but contained no stones. The pancreas was enlarged and hard, with areas of boggy softening and necrotic spots. The patient took the anæsthetic very badly and at all times during the operation his condition was a cause of grave concern. For this reason, and on account of the fact that he had been practically asymptomatic prior to operation, it was considered inadvisable to subject him to any prolonged surgical procedure. Therefore drainage was instituted through the original incision and through a stab wound in the left lower quadrant and the abdomen closed. His convalescence was uneventful.

The patient was examined October 30, 1929. His wound was firmly healed, and there was no hernia. He had been working steadily since shortly after his discharge from the hospital and had suffered no inconvenience. His digestion was rather better than before operation and he had had no further attacks of pain. He considered himself well.

Doctor Goldsmith remarked that it seems reasonable to suppose that this man had suffered an attack of acute hæmorrhagic pancreatitis on two occasions prior to operation. The etiology was probably a chronic bile-tract inflammation with extension along the pancreatic duct. It is likewise probable that he would have recovered without operation, since the acute symptoms had subsided before he came to the hospital. It is recognized that because of the non-removal of a diseased gall-bladder he may have a recurrent attack of pancreatitis, but it was felt that a cholecystectomy would have jeopardized his life at the time of operation. He has since refused to have this procedure carried out.

The clinical picture of hæmorrhagic pancreatitis is ordinarily so striking and presents features of such gravity that it is properly considered to be one of the most dangerous of intra-abdominal lesions. That this is not always the fact, however, is indicated by the subjoined case, which is interesting for the reason of the disparity between the clinical symptoms and the pathological findings.

This case is presented to indicate the difficulty in making a diagnosis of pancreatitis on the evidence obtainable, as well as to call attention to the fact that the peritoneum has higher powers of resistance to the pancreatic enzymes than is generally realized. It is likely that many cases of pancreatitis of this character recover spontaneously and are never recognized.

RECURRENT TUBERCULOUS LYMPHADENITIS OF THE  
AXILLA AND NECK

DR. DAMON B. PFEIFFER presented a man aged thirty-one years, who first noticed several small enlarged nodes in the axilla and the neck on the right side in the Fall of 1923. They were not painful or sore to touch. On account of their gradual enlargement several months later one of them was removed for examination. The microscopical diagnosis was tuberculosis.

The patient was exceptionally robust and healthy. The family history was negative, and there had been no known exposure to tuberculosis. He had had no illnesses except measles, chicken pox and possibly diphtheria in childhood. Examination of the lungs was negative and has remained so up until the present. The axillary nodes were larger than the cervical, varying from barely palpable nodules up to one or two centimetres in diameter. No history could be elicited of a wound or sore on the hand, arm or adjacent trunk which might be construed as a portal of entry. The tonsils were moderately enlarged and injected. The palpable glands in the neck were all in the supraclavicular triangle. None could be felt in the submaxillary region, though his stocky, thick neck could easily have caused one to overlook moderate enlargement of the deep glands. It was decided to have the tonsils removed, which was done together with some adenoid tissue October 10, 1924. Microscopical examination was not made. It seemed likely that such an exceptionally healthy appearing individual would be able to deal with the glandular infection after removal of the troublesome primary focus.

He was readmitted to the Abington Hospital, January 27, 1927, slightly more than three years later. His general health had continued to be excellent. The cervical nodes had diminished in size and were entirely quiescent. The axillary nodes now formed a conglomerate mass as large as a lemon. The mass was removed *en bloc* and there has been no recurrence in this region.

Two years later he was readmitted with marked enlargement of the cervical glands on the right side, which had begun suddenly two months before. There were many glands in all the lateral triangles. They were tender and quite highly inflammatory in character. One in the post auricular area had evidently undergone partial softening. The general health was still excellent. The throat appeared normal. January 24, 1929, the glands were removed by what amounted to almost a bloc dissection. A part of the sternomastoid was involved and was removed. The spinal accessory nerve had to be dissected from an inflammatory mass which completely enveloped it. Fortunately, no paralysis resulted. Enlarged glands were present in the substance of the lower pole of the parotid gland which was resected. A temporary partial facial palsy followed which rapidly cleared up. Recovery was uneventful.

Four months later, May 12, 1929, he was again admitted on account of glandular swelling which had suddenly come on in the submaxillary triangle on the left side. Realizing from previous experience that spontaneous subsidence could not be expected a wide excision was made of the infected glands and of the adjacent lymphatic bearing tissue as well. There has been no recurrence on this side.

Three weeks ago a sudden enlargement began just below the mandible on the right side. This is in a spot which was spared in the former dissection because of danger of damaging the submaxillary branch of the facial nerve. Doctor Pfeiffer decided to try the effect of a few X-ray exposures on this single isolated gland. The diagnosis in this case has been verified by two guinea pig inoculations from glands removed at the second and third operations.

DOCTOR EIMAN expressed the opinion that the infection is probably of the bovine type. If so, this disease may have come originally through tonsillar infection from milk or butter.

DOCTOR PFEIFFER remarked that this patient is an example of a surgical condition, once common but now rather rare. The reasons for this decreased frequency are (1) the diminution in all forms of tuberculosis, (2) the sanitary precautions thrown about milk and dairy products, (3) the common removal of tonsils and adenoids which are the usual primary foci and (4) the idea that glandular tuberculosis, even if present, is not a surgical disease. It is well to sound a note, now and then, that this latter idea is not altogether correct. It is true that many cases of tuberculous lymphadenitis particularly in children, will regress, become symptom free and quiescent after removal of primary foci, and institution of the well-known hygienic measures directed towards the control of tuberculous infections. The use of the X-ray, ultra-violet light, tuberculin and local measures such as aspiration of softened glands have all enjoyed at times considerable popularity as adjuvants in treatment. The X-ray has established itself as a valuable agent in certain cases, ultraviolet light as well as X-rays are often successful in clearing up simple persistent tuberculous sinuses. Tuberculin has not fulfilled the early hopes. Aspiration of softened glands and injection of various substances has met with no favor in this country. Local applications and counterirritants have been found to hasten softening in many cases. In the multiplicity of measures available and at times successful, it would appear that the profession is not clear upon the relative values of the various methods. There can be no question that it is of paramount importance to remove the primary focus in all cases of glandular tuberculosis. In cervical adenitis this usually means tonsillectomy and adenoidectomy. Also, it is equally important to institute the recognized antituberculosis regimen. There can be no objection to ray or light therapy for a reasonable trial. It must not be overlooked, however, that not all glandular infections can be disposed of in this manner and one should be alert to note those which continue to progress or are lagging unduly under such measures. Dowd, long ago, showed incontestably that the removal of tuberculous cervical glands, while they are still confined to the earliest involved groups in the superior deep cervical chain is almost invariably followed by complete and permanent cure. Hanford more recently has confirmed this experience. This year, Miller and Shedden in reviewing the cases for the Massachusetts General Hospital have pointed out an additional reason for early removal of these glands. They were able to trace 132 of 204 cases and found that 29 (22 per cent.) had died of some form of tuberculosis. They quote the recent opinion of experts in tuberculosis that glandular tuberculosis is often associated with a mild bacteremia. The path is from the primary focus to the nodes, thence to lymphatic trunks and onwards to the venous system, then to the lungs and in many cases to the systemic circulation. While the incidence of glandular tuberculosis is greatly lessened at the present time, it is worth while to call attention again to the

serious results that often follow delay and neglect of these lesions and to remind the profession that in early surgical removal of primary lesions and primarily infected glands, we have the best insurance against local spread and systemic involvement.

DR. JOHN H. JOPSON said that this case raised the question as to the point of infection. In tuberculous glands of the neck, of course, the point of entrance is generally in the throat, but in tuberculous lymphadenitis of the axilla and groin the hand or foot may be the site of the initial lesions. The speaker recalled a case which had come under his care in which axillary involvement was traced to an injury to the finger and the connection between the injury and the condition of the axilla was shown with sufficient clarity to convince an Indemnity Insurance Company. The patient had been engaged in unpacking pottery which was surrounded by straw; an injury to the finger by a thistle in the straw was the apparent portal of entrance for the tuberculosis. This man quickly developed a large mass of tuberculous glands in the axilla with mixed pyogenic infection which Doctor Jopson removed. The infection was probably of the bovine type. Doctor Jopson agreed with Doctor Pfeiffer that these cases were best treated by surgery which as C. M. Dowd has shown will cure 85 per cent. of the cases in one operation. At least in children. Although tuberculous lymphadenitis is not seen nor discussed with anything like the frequency of a number of years ago, Doctor Jopson remarked that it was still very common in the colored race and that in his service at the Graduate Hospital, where a large number of colored patients are treated, he still sees the very worst type of cases.

DR. GEORGE M. DORRANCE said that in his experience years ago surgery alone had been extremely unsatisfactory. He has had excellent results since using X-ray and surgery and X-ray combined with local removals and not radical excisions. It is taken for granted that these patients must have all foci of infection in the mouth removed and must be treated with sunshine, fresh air and forced feeding the same as any other tuberculous patient. The speaker did not believe that the results, including a certain mortality, justify radical excision.

DR. JOHN H. JOPSON said that this question of the treatment of cases of tuberculous lymphadenitis in the neck especially is an old quarrel between Doctor Dorrance and himself. The fewer of them are being operated upon because fewer cases occur. The same is true in London where the present statistics show a marked reduction of the number of such cases observed and operated upon. This is apparently due to the fact that the milk supply of the city of London has been cleaned up and fewer patients become infected with the bovine type of tuberculosis. Doctor Dorrance's optimism is hard to understand, especially in view of the fact that one finds no such attitude in consulting the best X-ray men of this city. Doctor Jopson reiterated his position by stating that he believed the condition to be essentially a surgical one in the stage in which the majority of cases were encountered and that operation was justified and indicated.

## CHEMICAL STIMULUS IN WOUND HEALING

### THE NATURAL CHEMICAL STIMULUS FOR CELL DIVISION

DR. F. S. HAMMETT, by invitation, remarked that a fundamental discovery would be that of the chemical differences between a cell in mitosis and one resting. The work at the Research Institute of the Lankenau Hospital began with this problem. It was known that lead would retard cell division, from the work of Blair Bell and his assistants. How it did, remained to be investigated. Growing root tips of onions, corn and beans in standard cultures containing a small amount of lead nitrate showed that the lead was precipitated in the region of active cell division and that further, this precipitate was very much more abundant within the nucleus than at any other place. Chemical analysis under the microscope brought out the fact that this was a compound of lead with the organic radicle  $-SH$ . Numerous compounds were tested in pairs, one containing  $-SH$  and the other exactly similar except that another radicle, usually  $-OH$ , was contained within its molecule instead of  $-SH$ . It was found that the compounds containing the available  $-SH$  group stimulated mitosis in plants, in paramecia and in rats. Experiments with the latter were done in this way: Two equal-sized pieces of skin were excised from a rat, one on each side of the flanks. Thio-glucose was placed on the right wound and glucose on the left. Those wounds treated with thio-glucose healed more rapidly than the others. That is to say, the thio-compound stimulated cell division to healing. The use of this radicle in man was then undertaken with the results as outlined below.

These results are to be found in detail in "Protoplasma," 1928:1929, and the Journal of Experimental Medicine, 1929.

### THE USE OF THE NATURAL CHEMICAL STIMULUS FOR CELL DIVISION IN WOUND HEALING

DR. STANLEY P. REIMANN, by invitation, said that a colored man, seventy-eight years old, with an ordinary varicose leg ulcer of twelve or more years' duration was first treated. One-half of the wound was flooded with thio-glucose; the other half was painted with mercurochrome. At the end of twenty-four hours about two square inches of epithelium had grown on the thio-treated part. No progress was made on the other half. This wound healed in two weeks sufficient to allow the application of a plaster case for a fractured thigh for which the patient had been admitted to the hospital.

Similar experiences were encountered in several other leg ulcers and in several bed sores.

The thio-glucose, as prepared by Doctor Toennies, Organic Chemist to the Institute, was used in a one to ten thousand slightly acid solution and applied as a wet dressing.

There can be no doubt that these thio-compounds stimulate the rate of cell division. But much further clinical experimentation will be necessary to determine the most advantageous compound to use; whether it is better to use as a wet dressing, or by the drip method, to use it constantly or interruptedly, etc.

Thio-glucose also stimulates bacterial growth and it was thought that perhaps coupling the thio-radicle to a substance like phenol or cresol would overcome this objection. Later experiments, using thio-cresol, bore out this idea, for several leg ulcers and a bed sore treated with these substances showed a minimum amount of surface pus. Once again, however, the most advantageous concentrations and means of application require further investigation. For further details of this work see 1929, Reimann, S. P., and Hammett, F. S., *Proc. Soc. Exp. Biol. & Med.*, vol. xxvii, pp. 20-22.

DR. ASTLEY P. C. ASHURST confessed to more or less ignorance, regarding SH and OH groups, etc., but said that he was aware of the fact that rest in bed, elevation and strapping with adhesive plaster would cure leg ulcers.

#### STATED MEETING HELD DECEMBER 2, 1929

#### HÆMOLYTIC ICTERUS; SPLENOMEGALY, MULTIPLE ABSCESES OF SPLEEN, SPLENECTOMY

DR. NORMAN S. ROTHSCHILD presented a young woman, aged twenty years, who was admitted to the Northern Liberties Hospital, in the service of Dr. Leonard Averett, September 14, 1928, with the history of having had a three months' pregnancy interrupted six days before. This condition was accompanied by severe hæmorrhage. The patient complained of severe pain in the left lower abdomen and pelvic examination revealed a uterus somewhat larger than normal, enlargement being due to subinvolution and not to retained products of conception. The left tube was enlarged and tender; the involvement of the right was the same, but to a lesser degree. The abdomen was not distended; there were visible pulsations. Liver dulness was increased about two inches below the costal margin. The spleen was palpable. A soft systolic murmur was transmitted to the vessels of the neck and to the axilla. The heart sounds were weak. Her skin was greenish yellow in color. Temperature was  $103 \frac{2}{5}$ , pulse 118, respirations 28. Blood pressure, 100 over 60. The blood count was erythrocytes 1,700,000, hæmoglobin 28 per cent. and 8,100 leucocytes. The urine showed albumen and twenty erythrocytes to the field.

Her previous medical history was very interesting. She stated that she had been a patient in the Children's Homeopathic Hospital two years ago, suffering with jaundice, anæmia and an enlarged spleen. This jaundice was noted by her sisters and brothers for many years and she was constantly the subject of teasing because of her yellow color. A report from the hospital stated that she was admitted with a severe anæmia, jaundice, and an enlarged spleen, which extended into the left iliac fossa. Her blood count at that time was as low as 2,200,000 erythrocytes and 48 per cent. hæmoglobin. The Van den Bergh was direct; delayed and indirect; bilirubin slightly positive. Fragility of red corpuscles, complete hæmolysis in 0.44 per cent. salt solution.

The following day she was given 200 cubic centimetres of blood and showed a slight improvement. The temperature began to approach normal and 400 cubic centimetres of blood was given two days later. Eleven days after admission her temperature rose to 104, then to  $104 \frac{4}{5}$  with some remission and then to 106. Her pulse and respirations increased with the temperature rise. She was again transfused, 300 cubic centimetres of blood being given. The transfusions were not attended by reactions. Blood cultures were sterile. The blood counts showed but a slight increase in the erythro-

cytes and hæmoglobin from the transfusions. The icteric index at first 9, rose to 60. The Van den Bergh at first delayed direct, became moderate direct. A firm mass, tender to touch, developed in the left lumbar region. Possible kidney involvement was considered and a pyelogram was made. X-ray findings of Doctor Bruck were as follows: "A large dense mass is seen in the left abdomen reaching down to the crest of the ilium and a little below it which merges in its upper portion with the shadow of the spleen. It is too far external to be the kidney." The jaundice increased and there was considerable tenderness over the gall-bladder. Cholecystographic studies showed that the gall-bladder was not definitely outlined. No dye stained shadows of stones were seen and after the ingestion of food, there was no change in the appearance. The conclusions were that the failure of the gall-bladder to outline in spite of the absorption of most of the dye, was suggestive of a chronic gall-bladder condition with obstruction in the cystic duct.

Doctor Rothschild saw the patient eighteen days after admission, and because of the enlarged spleen and the history of its enlargement two years before, the character of the temperature, which was "pump handle," the history of the pelvic infection and the general condition of the patient, felt the condition to be a blood stream infection despite negative blood cultures, and recommended the use of Pregl's iodine or mercuriophan intravenously. Dr. S. A. Lowenberg saw the patient the same day and made the following report: "Because of previous history of enlarged spleen and anæmia, both of which have become aggravated with the acute infection, it is plausible to consider that she has a chronic splenomegaly superseded by an acute infectious splenitis." He recommended X-ray treatments. Intravenous therapy and X-ray treatments had no affect upon the patient. Biliary drainage was performed with good results, the jaundice being less. This procedure was performed every day with some relief to the patient. The jaundice, however, varied at times. Numerous attacks of severe sharp pain in the left lumbar region occurred and these were interpreted as emboli of the spleen. The bleeding time was three and one-half minutes and the coagulation time was five and one-half minutes. Repeated pelvic examination showed these organs to have returned to the normal size.

The patient's general condition did not improve, and on December 4, 1928, splenectomy was performed. The spleen was adherent to the diaphragm, to the stomach, transverse colon and descending colon. The diaphragmatic adhesions were separated with considerable difficulty, but without hæmorrhage. The other adhesions were severed between ligatures. As the pedicle was brought into the wound there was spill of pus from the spleen. The vessels were doubly ligated and severed. No accessory spleens were seen. Because of the spill of pus the gall-bladder and liver were not inspected. The wound was closed in layers and drainage was instituted through a stab wound posteriorly. The patient's condition was very poor on the table and stimulation was resorted to. Her post-operative course was uneventful with the exception of an occasional rise of temperature to 101 to 102 and once to 103, then to a return to normal. The greenish yellow hue which this patient exhibited before operation gradually faded. The drainage was at first sanguineous but later became purulent. Slight tenderness over the gall-bladder was present at times, but duodenal lavage would relieve it.

February 19, 1929, she was readmitted complaining of a pain in the right and left upper quadrants and considerably jaundiced. She had a sinus in the abdominal wound from which greenish pus was discharging. There was tenderness and rigidity of the abdominal muscles in the upper quadrants.



## PHILADELPHIA ACADEMY OF SURGERY

The temperature and pulse were normal. Blood count showed 3,410,000 erythrocytes and 57 per cent. hæmoglobin. Icterus index 33, Van der Bergh direct immediate. Biliary drainage showed "A" bile only. Temperature remained normal about a week when she became toxic, temperature was elevated and she developed pain and tenderness in the left upper quadrant. The sinus was investigated under gas anæsthesia and a small amount of greenish pus exuded. Drainage was established. The temperature remained high for four days and then became normal until the time of her discharge from the hospital.

Seven months after operation she still complained of slight pain in the upper right quadrant and was receiving treatment in the gastro-intestinal clinic.

The pathological examination of the spleen was as follows. It measured 36x15x5 centimetres. The capsule appeared normal and on sectioning there was an abscess 5 centimetres in diameter, with a rough gray wall. There were several small abscesses scattered throughout. There were numerous yellow areas, which are firmer in consistency and are infarcts. The culture for this abscess showed pure colon bacilli.

### *Post-Operative Blood Studies Showed the Following Change in the Blood Picture*

Time	Erythrocytes	Leucocytes	Hæmoglobin per cent.
3 days.....	2,330,000	.....	40
4 days.....	2,790,000	.....	42
6 days.....	2,990,000	.....	40
16 days.....	2,990,000	.....	42
18 days.....	3,030,000	25,500	47
49 days.....	3,400,000	15,600	.....
10 weeks.....	3,410,000	.....	57
7 months.....	4,500,000	12,800	75

The speaker remarked that Billings in his paper on Abscess of the Spleen reported three cases, two from blood stream infections. That of Doctor Jopson's from puerperal sepsis, his own from a carbuncle of the neck, and that of Doctor Klopp from a urinary tract infection. He states that as the evolution of the abscess progresses from the upper pole towards the thorax, or from the lower pole towards the general peritoneum, symptoms of a pleuro-pneumonia or abdominal nature may develop. The treatment of uncomplicated cases, is splenectomy, of the complicated, splenotomy. In this case splenectomy was performed without the knowledge of the existing abscesses, although the chief resident physician, Doctor Zimoring, believed this condition existed. Without splenectomy this patient's primary condition, hæmolytic icterus, would certainly have not been cured.

### PERFORATED DUODENAL ULCER WITH MULTIPLE SEQUELÆ

DR. EDWARD J. KLOPP reported the case of a man, twenty-seven years of age, who was admitted to the Memorial Hospital, September 10, 1928, with the diagnosis of perforated duodenal ulcer. He had had fairly definite ulcer symptoms for three years. The attacks were subject to seasonal exacerbations occurring most often in the fall and winter, subsiding during hot weather and would last for from five to eighteen weeks and disappear for a similar period. Two days prior to admission, three hours after breakfast, he complained of nausea and took no more food that day. The ulcer perforated on day of admission, five hours after breakfast, and he was

## PERFORATED DUODENAL ULCER WITH MULTIPLE SEQUELÆ

operated upon eight hours after perforation under nitrous oxid and oxygen. There was a moderate amount of turbid fluid in the peritoneal cavity. The ulcer was closed with a linen suture. A typical posterior gastro-jejunostomy was done using linen for the serous suture. A rubber covered gauze drain was inserted to the subhepatic space. Smears and cultures of the peritoneal fluid showed streptococci and staphylococci. Convalescence was satisfactory until the twelfth day when he had pain in the right lower chest and a temperature of 102. X-ray of the chest on October 6, 1928, revealed no evidence of a lesion above the diaphragm. The diaphragm was in normal position, but slightly restricted from its excursion. October 13, 1928, a right subphrenic abscess was drained by resecting a portion of the eleventh rib under local anæsthesia. Culture showed streptococci and staphylococci. October 19, there was X-ray evidence of right pleural effusion and an interlobar shadow suggestive of an abscess. He coughed considerably, continued to lose weight and his temperature was of the septic type. The symptoms and signs indicated a large collection of fluid in the right pleural cavity. X-ray on November 7, 1928, seemed to show less fluid than at the previous examination. November 18, 1928, the right chest was drained of a large quantity of foul smelling pus by resecting a portion of the ninth rib under local anæsthesia. Culture of pus obtained four days previously by aspiration of the chest showed large rods, most likely colon bacilli. At a subsequent X-ray examination a piece of rubber tubing three inches in length was found within the pleural sac. It was easily extracted with forceps. He had improved sufficiently to leave the hospital December 22, with pus draining from the pleural cavity and from the abdominal sinus. The wound to the subphrenic space had closed.

February 11, 1929, while a nurse was irrigating the abdominal wound with salt solution the patient coughed up the irrigating fluid and a considerable quantity of pus. He was admitted to the Pennsylvania Hospital two days later. Lipiodol was injected through a catheter in the abdominal sinus. It followed underneath the dome of the diaphragm to about its apex, at which point a very small shadow of lipiodol seemed to pierce the diaphragm and came to an abrupt end. They had expected to demonstrate a fistula between a bronchus and the abdominal sinus communicating through the diaphragm. Irrigation of the empyema cavity distinctly showed it to communicate with a bronchus. Lipiodol injected through the empyema wound showed a cavity of 2 or 3 cubic centimetres. He was discharged from the hospital, March 9, 1929, with no clinical evidence of bronchial fistula and the abdominal wound was healed.

April 8, 1929, he complained of severe headache which was continuous and was readmitted April 11, in a stuporous condition, moaning and mumbling of pain in the head. He did not move his left extremities. The neurologists consulted thought he had a brain abscess deep in the right frontal region with secondary meningitis. They advised against operation and the patient rapidly went into coma and died on April 14. Blood culture was negative. Spinal fluid examination showed a great many pus cells; no organisms. Culture showed no growth within forty-eight hours.

At autopsy there were adhesions extending from the incision backward and upward to the liver; no free fluid. The opening between the stomach was large, free of scars or adhesions. The mucosal surface of the ulcer showed it to be fairly well healed. No scars or adhesions were found about it except for the scar of the ulcer itself. A small portion of linen suture remained on the serosal surface. The upper and middle lobes of the right lung were rather dark and mostly air-containing. In the lower lobe a

bronchus extended into an area consisting of a central abscess of about 2-3 cubic centimeters in size with five or six smaller abscesses scattered near it. Adhesions obliterated the interlobar fissures quite well. There was no empyema cavity that could be distinguished. In the diaphragm there was no path or scar to indicate direct extension of pus from below upward. *Brain and skull.*—On exposing the skull just above the right motor area there was a superficial staining with blood. On removing the skull cap no evidence of deep lesion was found in the bone. The dura contained moderately injected vessels. On incision in the midline just anterior to the central portion of the brain considerable amount of dirty gray pus exuded on the slightest pressure. There was evidence of meningitis over the vertex. The medulla, pons and part of the cerebellum adjoining them were covered with a thick, yellow plastic exudate possibly greater on the right side. The culture showed colon bacilli and staphylococci. The abscess was later reported to have been in the frontal and temporal lobes.

The reporter stated that he had lost three patients with perforated duodenal ulcer in which there was subphrenic infection. In one of these a drain had been placed between the liver and diaphragm. He developed empyema. Autopsy showed a necrotic area in the diaphragm 3 centimetres in diameter with perforation. Another case, not his own, died three days after the operation for perforated ulcer, from respiratory infection. Autopsy also showed a gangrenous patch in the diaphragm without perforation. The peritoneum was wiped fairly dry in the case reported. It is difficult to prevent subphrenic infections in these cases.

#### RUPTURED ADENOMA OF THE THYROID

DR. HENRY F. ULRICH, by invitation, reported the case history of a man forty-two years of age who was admitted in the service of Dr. Charles H. Frazier at the University of Pennsylvania Hospital July 11, 1929. His chief complaints were: difficult breathing which appeared suddenly, and with swelling of and pain in the neck. For eight years previous to admission he had had an enlargement of the right lobe of his thyroid which from his history was undoubtedly a toxic adenoma. About three hours before his admission to the hospital, while having a friendly tussle with a friend, he suddenly developed a sense of suffocation, was unable to speak and could breathe only with great difficulty. Immediately he developed severe pain in the base of his neck as the neck became swollen and tense. Severe dyspnoea persisted for about one hour, but was considerably relieved at the time of admission. By that time, however, the swelling had increased and dysphagia became a troublesome complaint.

His past medical history and family history were negative.

He was a well-developed large man. Blood pressure 140/70; temperature 99.4; pulse 100; respirations 22. The face was flushed and slightly dusky. Eyes, ears, nose and mouth were grossly negative. Neck showed a tense infiltrating swelling of almost the entire anterior and lateral aspect, more marked on the right side. There was no discoloration or oedema of the skin and the mass was only slightly tender. Heart and lungs were essentially negative.

Dr. I. S. Ravdin saw the patient soon after admission and made a diagnosis of ruptured adenoma of the thyroid with hæmorrhage into the neck. As the patient was in no eminent danger from tracheal compression, operative intervention was voluntarily delayed. The patient was given a hypodermic of morphine sulphate grains 1/6 and atropine sulphate grains

1/150 and an ice-collar was applied. He had a fairly comfortable night. The following day Dr. Gabriel Tucker examined the patient and reported as follows: "Examination of the pharynx shows considerable bulging on the right side of the posterior pharyngeal wall. The mucosa is bluish in appearance. Acinitis and discoloration extends around the right lateral wall of the pharynx, the base of the tongue, and the epiglottis. There is considerable swelling in the pyriform sinuses on either side, apparently due to swelling of the posterior and lateral pharyngeal walls. Larynx—motility normal, although there is considerable displacement of the larynx toward the left with tilting toward the left side. Both sides seem to move equally. No evidence of compression of the trachea on mirror examination. This, of course, does not exclude the lower portion of the trachea, as only the upper two or three rings could be seen with the mirror. Patient was not dyspnoeic at the time of examination. This condition could arise from a submucous hæmorrhage into the tissues of the pharynx extending around the lateral and posterior walls.

During this day there was gradual but increasing dyspnoea until 5.30 P. M. when the patient was operated upon under local anæsthesia by Doctors Frazier and Ravdin. A mass consisting of ruptured adenoma and blood clot the size of a small grapefruit was found. The blood had infiltrated all the muscles of the neck including the pharyngeal wall. The sterno-cleidomastoid muscle, which has its own sheath, was also infiltrated and clots filled the retrotracheal space from the level of the sterno-clavicular articulation to the mandible. There was some infiltration of blood on the left side. A right lobectomy was done, the wound packed with iodoformed and vaseline gauze, and left open. Hæmostasis was complete at the close of the operation. The post-operative convalescence was uninterrupted until June 21, when a secondary closure of the wound was done. June 28 the patient was discharged with the wound still draining some serum. July 4 the discharge from the wound became purulent and the patient said his neck became painful. On July 13 he was readmitted to the hospital with a marked cellulitis of his neck. At this admission he had some dysphagia but no dyspnoea. Temperature was 102, pulse 98. The incision was reopened under local anæsthesia that evening and packed with iodoformed gauze. Moist heat was kept on the wound and at the end of twenty-four hours his temperature and pulse were normal, and remained so until discharge on the ninth day. During this admission he was again examined by the Bronchoscopic Service who reported the pharynx and larynx normal.

Six weeks later the patient reported that his wound was healed and that he was doing his usual work with no discomfort.

Primary emergency surgery of the thyroid gland is decidedly unusual. The outstanding indication for such is hæmorrhage, either into the gland or from the gland into the neck, of sufficient amount as to cause respiratory embarrassment. Hæmorrhage may be spontaneous or the result of trauma. There is considerable variety in the degree of hæmorrhage encountered, from that reported by the pathologist, in specimens of small adenomas with cystic changes to the massive hæmorrhage causing such tracheal compression that death would ensue without prompt intervention.

The largest series of cases of spontaneous hæmorrhage into a goitre which has been published is that reported by Schwoerer<sup>1</sup> who found 18 such cases among 2,500 goitre patients, with a mortality of 27.7 per cent. Von Ziemack<sup>2</sup>

reported one case in which the subcutaneous extravasation spread down the chest and abdominal wall as far as the umbilicus. Haim<sup>3</sup> reported several cases of spontaneous hæmorrhage into strumous thyroids. Deegan<sup>4</sup> has recently reported a case which is strikingly like ours.

Gunshot and stab wounds were responsible for the traumatic cases reported by Alamartine<sup>5</sup> and Lenormant.<sup>6</sup>

The diagnosis of rupture of an adenoma of the thyroid with hæmorrhage into the neck should not be difficult, especially when history of preceding goitre is obtained. A history of sudden increase in the size of the neck with phenomena of compression makes it a reasonable supposition. The symptoms of hæmorrhage reach a climax and subside more quickly than in acute inflammation of the thyroid (Crotti).<sup>7</sup>

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- <sup>2</sup> Von Ziemack, J. C.: S. G. & O., vol. xxvii, p. 539, 1923.
- <sup>3</sup> Haim, E.: Arch. f. Klin. Chir., vol. cli, p. 595, 1928.
- <sup>4</sup> Deegan, J. K.: Clifton M. Bull., vol. xv, p. 85, 1929.
- <sup>5</sup> Alamartine, H.: Presse. Med., vol. xxvii, p. 107, 1919.
- <sup>6</sup> Lenormant, C.: Presse. Med., vol. xxxvi, p. 1919, 1928.
- <sup>7</sup> Crotti, Andre: "The Thyroid and Thymus," Lea and Febiger, Phila., 2nd ed. p. 108, 1922.

#### PHRENIC NERVE STIMULATION IN DIAPHRAGMATIC HERNIA

DR. RICHARD OVERHOLT, by invitation, read a paper with the above title for which see page 381.

DR. GEORGE P. MULLER said that he wished to emphasize the point brought out by Doctor Overholt regarding the excellent relaxation of the abdominal wall by spinal anæsthesia and of the diaphragm by the phrenic nerve freezing. Often in the literature, the old approach is condemned because of the difficulty of operation, but these procedures made operation exceedingly easy. The speaker was disappointed with the recurrence, but would be willing to operate again and use silk sutures. The suturing was very carefully done with chromic catgut mattress sutures, overlaid with staggered interrupted sutures. Doctor Overholt and he had read Harrington's article, but were not aware that the preliminary stimulation of the phrenic nerve had been done before as an aid to diagnosis. This was Doctor Overholt's suggestion and it worked out quite well.

#### MORTALITY AND END RESULTS OF OPERATION FOR ABSCESS OF THE LUNG

DR. GEORGE P. MULLER read a paper with the above title for which see page 361.

# TRANSACTIONS

## OF THE

# NEW YORK SURGICAL SOCIETY

STATED MEETING HELD DECEMBER 11, 1929

The President, DR. EDWIN BEER, in the Chair

### PHRENIC NERVE RESECTION FOR LOWER LOBE BRONCHIECTASIS

DR. IRA COHEN presented a man, thirty-six years of age, who in July of this year was admitted to Mt. Sinai Hospital, stating that two years before, he had had a tonsillectomy performed; about three weeks after which he had pain in the left chest posteriorly and a heavy feeling in the anterior part of the chest, with chills, fever up to  $105^{\circ}$ , and a cough with profuse foul sputum. This episode lasted five weeks and then all symptoms disappeared. For more than a year he remained well. In October of last year, he had an acute respiratory infection which lasted a week and was followed by a persistent cough with foul sputum. This subsided in part but he was never free. Four weeks prior to his admission to the hospital he began to run fever up to  $102^{\circ}$ . Sputum became profuse and he suffered again from pain in the left chest. A week prior to admission, he had a hæmoptysis after which his temperature became normal but the cough, sputum and pain persisted. He had lost eighteen pounds in weight in two years and for a month was too weak to work.

The patient looked ill. He had some slight curving of finger nails. There was dulness with diminished breath and voice sounds at the left base. His hæmoglobin was 71 per cent. All other laboratory tests except X-ray were negative. The X-ray of the chest showed irregular infiltration of the left lower lobe with pleural and pericardial adhesions.

He was bronchoscoped by the laryngological department and the middle branch of the left lower lobe bronchus was found dilated and pus was seen coming from it. Iodized oil was injected into the trachea and the patient was X-rayed. This plate brought out the small bronchiectatic cavities and dilated small bronchi. It was felt that he would be improved by compression of the lower lobe obtained by means of a phrenic nerve resection. This was done August 13. Two days later fluoroscopy and X-ray showed the elevation of the left side of the diaphragm. He left the hospital five days after the operation. He has improved and has returned to work. Occasionally in the morning he coughs and brings up a teaspoonful of sputum which at times has an odor. He has also a sense of fullness in the front of the chest. The patient is being shown improved, though not cured, following his operation. As the lung involvement was not widespread and was confined to the lower lobe, he seemed to be a particularly favorable case for this type of operation.

Doctor Cohen presented this patient not as a cured but as an improved case. An interesting fact in connection with it was that on the morning following the operation the patient volunteered the information that his cough was easier and that the expectoration had diminished.

DR. HOWARD LILIENTHAL said he had done several phrenic nerve resections for this purpose and so far had not succeeded in curing a patient, in spite of the fact that there was complete paralysis of the diaphragm on the affected side. These patients have remissions, and he believed this patient had had a remission although he hoped that the present one will prove to be not a remission but a permanent cure. It was to be hoped that he will be presented again in say one year and again in five years to see if he remains well. On examining these cases with the X-ray it is important not only to fluoroscope them but to take a film on deep inspiration and one in deep expiration so as to have a record of the rise of the diaphragm. Another important point was that in performing artificial pneumothorax it must not be forgotten that this will push the diaphragm down, sometimes to a great degree. This should be borne in mind by those doing operations of this character so they will not trust entirely to what they see in the röntgenograms.

#### FASCIAL SARCOMA OF THIGH

DR. IRA COHEN presented a man who in March, 1921, when forty years of age, was admitted to Mt. Sinai Hospital because of swelling of his left thigh. This had begun six years previously as a small painless lump above the knee. Two years later it began to grow slowly and gave him some pain. For two years prior to admission the growth had been more rapid. He had lost twenty pounds in weight in these two years. He had a persistent cough which at times was productive. He had not had any hæmoptysis or fever. There was a history of a chancre some twenty years ago. Aside from the local condition the only positive physical finding was unequal pupils which failed to react to light. Laboratory tests including Wassermann were negative. On the anterior surface of the left thigh, about in the centre, was a hemispherical tumor which measured twenty-two centimetres from above down and from side to side. The left thigh measured fifty-one centimetres in circumference at the most prominent part of the swelling—the right thigh, thirty-seven centimetres at a corresponding point. The skin over the tumor was bluish in color. The mass itself seemed somewhat cystic. It was not attached to the bone, and seemed to be drawn up into the quadriceps when it contracted.

With a pre-operative diagnosis of sarcoma, operation was performed March 10, 1921. A small probatory incision revealed necrotic tumor. An elliptical incision was made through the skin. The muscles were divided well beyond the growth. The femur and femoral vessels were laid bare. After removal of the growth, tissue which macroscopically seemed involved was excised from along the course of the femoral vessels. The muscles sacrificed were practically all the components of the quadriceps femoris from six centimetres above the patella upward to ten centimetres from Poupart's ligament. Part of the tensor fasciæ femoris and most of the sartorius were also sacrificed. Closure was made by suturing the tensor fasciæ femoris to the adductor group. A tube drain was inserted into the dead space after suturing the skin. The specimen, which was the size of a small football, was made up of muscle and fascia infiltrated with tumor tissue in part necrotic. There were signs of a hæmorrhage into the upper part. The report from the pathologist was spindle-cell sarcoma. The patient was discharged on the

## CARCINOMA FOLLOWING RADICAL MASTECTOMY

nineteenth post-operative day. A small superficial sinus remained. He was referred to the department of radiotherapy for X-ray treatment.

Ten months later, in January, 1922, he was sent into the hospital again from the follow-up clinic because of a cough with blood-streaked sputum and pain in the right axilla and dorsal spine which he had noticed for six weeks. He claimed to have lost ten pounds in weight. A small nodule was seen in the left supra-patellar region. There was dulness with diminished breath and voice over the left upper lobe. X-ray examination of the chest showed an extensive pleuritic process of both bases. The nodule in the scar was excised and reported chronic inflammatory tissue. This time his Wassermann reaction was 4 plus.

The patient was lost sight of for some years. Recently, he reappeared because of hemorrhoids. He was now presented as a late result following excision of an extensive sarcoma, and because, in spite of the sacrifice of considerable muscle, the function of leg is very little impaired.

DR. FREDERIC W. BANCROFT raised the question whether, in reviewing the case, the original microscopic diagnosis of sarcoma should not have been gumma.

Doctor Cohen replied that the same thought had occurred to him, as the result of which he went to the pathological laboratory to have the slides reviewed. At the time the patient was operated on, in 1921, Doctor Mandelbaum was pathologist at the Mt. Sinai Hospital. The present pathologist, Doctor Klemperer, examined the slides. The first one looked at, he called a gumma but this slide was made from the nodule which had been removed from the scar at the second operation. The original slides were finally found and Doctor Klemperer said, "This is undoubtedly sarcoma."

## CARCINOMA OF REMAINING BREAST FOLLOWING RADICAL MASTECTOMY

DR. IRA COHEN presented a woman who in June, 1924, when forty years of age, noted a lump in her right breast, which she states developed following a blow from the corner of a food truck. She failed to report the presence of this tumor until January, 1925, at which date there was a hard fixed tumor in the outer half of the right breast with obvious axillary node involvement. She was given one pre-operative X-ray treatment and a radical mastectomy was done. The pathological report was medullary carcinoma with metastases to the axillary nodes. Following the operation, she was given X-ray treatment. In August, 1925, while under treatment, a small nodule appeared in the left supraclavicular region which disappeared.

In October, 1926, one year and nine months after the first operation, in the course of a routine follow-up examination, a small tumor was felt in the left breast, below the nipple. There was some retraction of the nipple. No axillary nodes could be felt. X-ray examinations of spine, pelvis and lungs were negative for metastases. A report from a frozen section done at time of operation, November 9, 1926, was carcinoma. Radical removal of the left breast was then performed. As in the first breast, the specimen was reported medullary carcinoma with involvement of one axillary node. She had further X-ray treatments after the operation, none since early in 1927. It is nearly five years since her first operation and more than three years since the second. She has remained well. Recent examination fails to disclose any metastases.



Involvement of a remaining breast by carcinoma after radical mastectomy while not frequent is not excessively rare. The second carcinoma is usually considered a metastasis. It is of interest that in this instance, as in some other cases reported, removal of the second breast is followed by freedom from further disease over long periods of time. Although the carcinoma in the second breast is usually considered a metastasis, the fact that no other metastases are noted and that the patient is often cured by mastectomy leaves the question open as to whether in some instances, one is not dealing with a second primary tumor.

DR. HOWARD LILIENTHAL agreed that this is probably a second primary carcinoma. A number of years ago he wrote a paper on the tendency to carcinoma and mentioned the case of a man who had carcinoma of the transverse colon which was resected and nineteen years later he came for treatment for carcinoma of the sigmoid. It was inconceivable that one had anything to do with the other. All surgeons have had cases in which carcinoma appears simultaneously in more than one part of the body.

#### FRACTURE ABOUT ANKLE-JOINT: LATE OPERATION WITH RESULT

DR. JAMES M. HITZROT presented a man, aged sixty, who broke his right ankle December 24, 1927. This was reduced under anaesthesia at a hospital and the leg put up in a circular plaster splint. His leg was kept in the plaster splint for six weeks and then removed and he walked on crutches for three months. After the removal of this splint he could not get his heel to the ground and walked about on his toes with considerable difficulty, and was able to walk only very short distances, about one block, and could stand for only a few minutes at a time. After use his leg swelled and became quite painful at the ankle-joint.

He was seen first by the reporter on October 29, 1928, approximately ten months after the injury. His right ankle was markedly deformed with the foot in the equinus position. The lower end of the tibia projected forward at the ankle-joint and the whole foot was displaced posteriorly and the heel was on a level with the projecting anterior portion of the tibia. The X-ray (Fig. 1) shows the lesion better than it can be described.

November 14, 1928, Doctor Hitzrot operated upon him, intending to do the operation, for old unreduced displacement, described by Stimson (*Fractures and Dislocations*, Phila., 1917, p. 463) which he had used successfully in old unreduced fractures, adding to it the lengthening of the tendo Achillis advocated by Dowd (*ANNALS OF SURGERY*, vol. lxviii, No. 3, Sept., 1918, p. 330) for recent fractures of the particular type to which this fracture belongs.

A four-inch incision was made, beginning on the right fibula and extending down the outer side of the leg to the dorsum of the foot. The site of the fracture in the fibula was exposed and the malleolus found to point posteriorly. So much new bone had formed that it was impossible to determine definitely the line of fracture. The fibula was divided in what was considered the line of fracture and the lower fragment mobilized. An internal incision was then made with its center over the lower end of the tibia and the lower end of the tibia exposed. The posterior portion of the tibia, which had been displaced backward, was then divided by an osteotome. This mobilized the lower end of the tibia which was then delivered through the wound on the inside of the leg. The scar tissue and new bone about the astragalus was then removed. A portion of the external face of the

articular surface of the astragalus had been eroded, and the articular surface of the astragalus was distinctly altered in shape. The tendo Achillis was so contracted that it was not possible to bring the astragalus forward. An incision was then made over the tendon and the tendon divided so that it could be lengthened, leaving the two long ends for subsequent approximation. When this was done it was perfectly obvious that the contraction of the soft tissues on the back of the leg and of the skin made the reduction of the displacement of the astragalus impossible, that is, the restoration of the normal ankle-joint was impossible. Any attempt to pull the foot down caused an immediate cessation of pulsation in the vessels in the foot.

The articular surface of the tibia was then projected from the wound and approximately one centimetre of the lower end of the tibia was removed with the saw. This left a broad surface which was reshaped so that it somewhat resembled the normal articular surface of the tibia. The astragalus was then placed in contact with the tibia and brought well forward and apparently established a satisfactory weight-bearing surface with the newly formed articular surface of the tibia. The under surface of the tibia was then smoothed off leaving a ridge on the inner side to form a new internal malleolus. A piece of bone was then removed from the fibula and the fracture line in the fibula reconstructed so that the course of the fibula was re-established to form the external malleolus of the ankle-joint. The reflected



FIG. 1.—Fracture at ankle; condition ten months after injury.

ligaments and anterior portion of the periosteum over the tibia were then sutured, reconstructing the anterior and internal portion of the ankle-joint. The external portion was also sutured in the same way, partially reconstructing the ankle-joint, especially on its internal and external aspects. The superficial wound was closed without drainage, using interrupted silkworm gut throughout. At the completion of these steps the astragalus apparently remained in position without any tendency to drop backward.

The divided halves of the tendo Achillis were then approximated, lengthening the tendon about five centimetres, and suturing the tendon in its lengthened shape under sufficient tension to maintain a very slight pull on its attachment, but not sufficient to tend to pull the astragalus backward. This superficial wound was also closed with interrupted silkworm gut. The foot was dressed with thymol-alcohol dressings and put up in moulded plaster

splints posterior and internal lateral, from the mid-thigh to the toes with the foot in adduction and slight inversion of the sole with dorsal flexion a little beyond a right angle.

Note.—So many secondary changes had taken place in the lower end of the tibia and on the articular surface of the astragalus that it was impossible to restore the normal joint. The contraction of the soft tissues of the back of the joint likewise made this correction impossible. Figs. 2 and 3 show the condition after operation.

He made an uneventful recovery. His splints were removed at the end of six weeks. Massage and baking were begun on the fourteenth day and the massage was continued for approximately six months. Motion at the ankle was begun on the twenty-first day. He discarded his crutches seven weeks after the operation and the walking splint sixteen weeks after the operation. His recovery of muscle power was slow and is still impaired, but he can now walk without difficulty and has a fair range of motion at the ankle-joint in both dorsal and plantar flexion. Doctor Hitzrot presented



FIG. 2.—Fracture at ankle; condition after operation—antero-posterior view.



FIG. 3.—Fracture at ankle; condition after operation—lateral view.

the case to illustrate: first, the danger which may result from the slipping of a corrected displacement inside a plaster splint, as described by Dowd; second, the failure of the ordinary reconstructive operation to meet the conditions; third, an operative procedure to meet the conditions found. So far as he knew no similar procedure has been previously reported.

The result has been so gratifying in this case that he believed that the removal of the projecting tibia with reconstruction of the ankle-joint may be a simpler solution for old uncorrected fractures of this type and would avoid the very extensive operation ordinarily required and which in this case could not be completed because of the circulatory disturbance produced when the soft parts were put under tension.

In reply to questions, Doctor Hitzrot said that there was sufficient cartilage on the upper surface of the astragalus to prevent ankylosis and the best weight-bearing surface of the tibial plafond was the central part. In the reconstruction the astragalus could not be completely brought forward owing to the enlargement of the tibia.

## ELBOW-JOINT FRACTURE WITH UNUSUAL LATE CHANGES

As to astragalectomy, his former experience in this type of fracture had been disappointing. In this case, and in the case of aviators who have crashed, where there are shattering fractures of the lower end of the tibia which also involve the astragalus, an astragalectomy gives a poor weight-bearing foot which is also deformed; also, when astragalectomy is done, the patients walk with considerable more difficulty than that demonstrated by the man shown here.

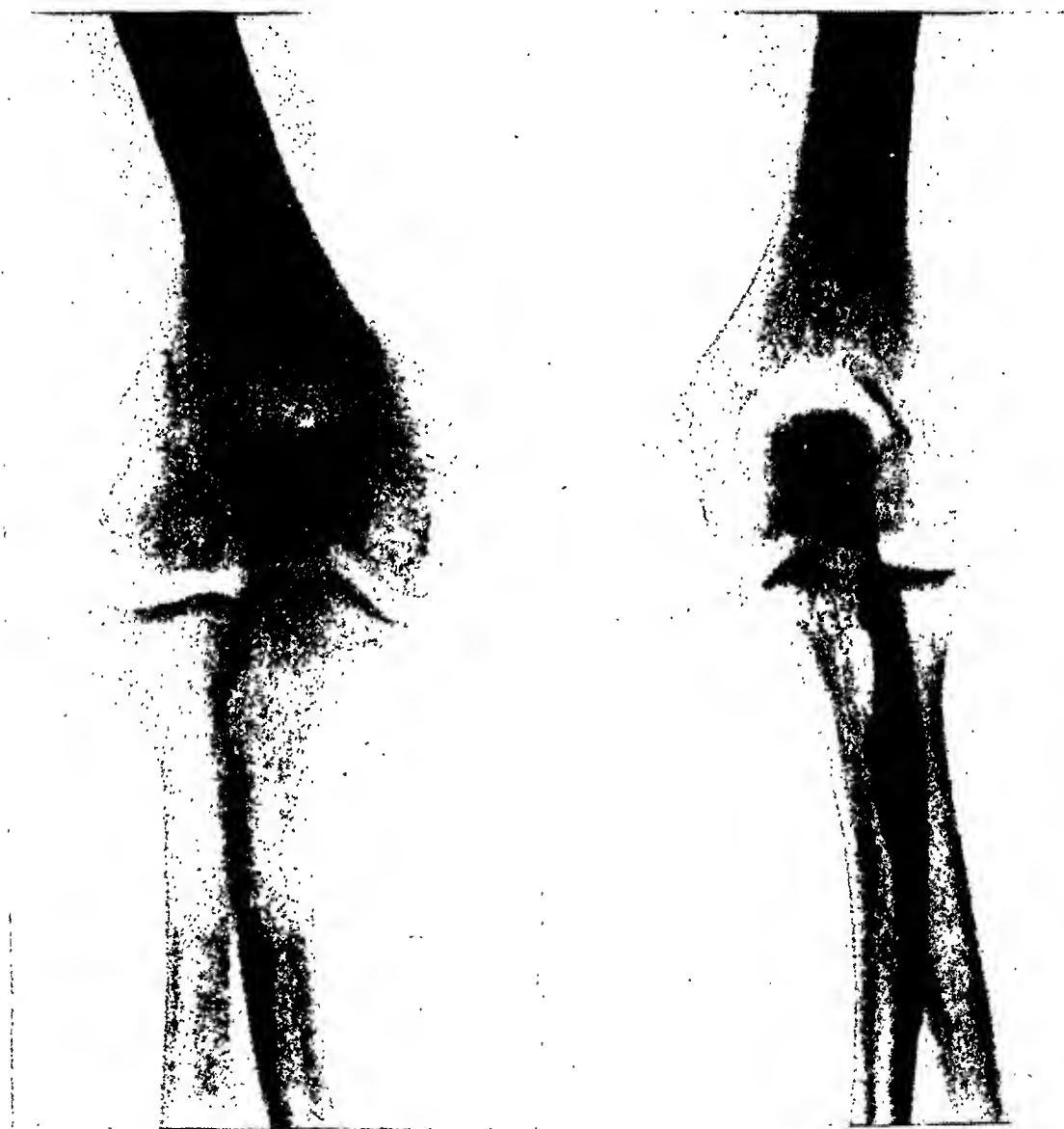


FIG. 4.—Old elbow-joint fracture—anterior view. FIG. 5.—Old elbow-joint fracture—posterior view.

## ELBOW-JOINT FRACTURE WITH UNUSUAL LATE CHANGES

DR. JAMES M. HITZROT presented a lad, aged seventeen, who was referred to him June 6, 1929, with a history of injury to his right elbow nine days before. The elbow was caught in a swinging door and squeezed. Since then his elbow has been swollen, painful and the motion had become markedly restricted. Ten years ago he fell fracturing this elbow. Until the present injury he has had good use of the arm except that he could not bend or straighten it completely.

When seen by the reporter the elbow was swollen; the chief points of tenderness were over the head of the radius, and the posterior aspect of the joint. In the region of the head of the radius there was a large bony mass which seemed to be a large radial head. Flexion at the elbow was limited to about ten degrees beyond a right angle and extension to about forty degrees beyond a right angle. Motions within these limits were quite painful. Pronation and supination of the forearm were both limited but not painful.

X-rays (Figs. 4 and 5) taken June 6, 1929, at the New York Hospital, showed an alteration in the size and shape of the lower end of the right humerus with a change in the shape of the articular surface and widening and distortion of the whole lower end, indicative of an old healed fracture. In addition there was an irregular mass of partially calcified bone or cartilage in the region of the lateral condyle which was irregular in shape, but which could only be seen in the anterior posterior view. The head of the radius was unusually large and the epiphysis had apparently united.

He was admitted to the New York Hospital June 12, 1929, and operated upon on the following day, by an incision over condylar ridge of humerus extending down over the head of the radius. The orbicular ligament was divided and the head of the radius removed through the neck. It was about three times the size of the normal head. Attached to the capitellum was a loose fragment, partially cartilage and partially bone. This was removed and involved the outer half of the capitellum, evidently indicating an old injury to this structure which had not united. During the manipulation of the joint a small loose body about the size of a good-sized pea escaped from the joint. Just where it originated could not be determined, but in all probability it was a fragment from the cartilaginous surface in the region of the fracture of the capitellum. At the completion of the operation and under an anæsthetic it was possible to make practically complete motions of the arm in all directions. He made an uninterrupted convalescence and his motion at the elbow now is practically complete. The case shows a very unusual change in the head of the radius as a late result, in an elbow fracture in a child.

#### SCLEROSING OSTEOMYELITIS OF CARPAL SCAPHOID

DR. JAMES M. HITZROT presented a woman, aged twenty-nine, who was referred to him May 15, 1929 on account of pain in her left wrist. About eighteen months before she had dropped a tire on her left wrist while changing a punctured tire on her car. The wrist at this time became swollen and painful. Although most of the swelling disappeared rapidly, the pain has remained constant. It is dull, boring and aching in character. When she holds anything in her left hand it caves in from lack of strength. For the past three months the pain has begun to affect her whole arm so that she hates to use her left hand for anything. Her past history is negative for previous injury or disease to this wrist. No rheumatism. Scarlet fever, diphtheria, measles, mumps and pneumonia when a child. Family history unimportant.

On examination the left wrist was slightly swollen on the dorsum in the snuff box. Active motions at the wrist were done slowly and were limited. Grip of the hand was weak and when she gripped anything she touched the snuff box as the region of pain. No superficial tender areas nor bone displacement could be found. Forced movements, especially radial adduction gave her pain in the region of the snuff box.

An X-ray report (Fig. 6) showed in the distal half of the left scaphoid

## SCLEROSING OSTEOMYELITIS OF CARPAL SCAPHOID

bone a ringlike shadow of sclerosed bone with a darker decalcified appearing central portion. In this darker area is a rounded very dense piece of bone about the size and shape of a green pea. Whether this is Garre's disease or some type of sclerosing bone tumor it is impossible to say. The question of diagnosis was a puzzling one. All clinical blood tests were negative. She was operated upon on May 20, 1929, by a two-inch incision beginning from the styloid process of the radius and extending down to the metacarpal of the thumb between the extensor tendons. This exposed the base of the the scaphoid. The bone at the junction of the capsule and the ligament was distinctly altered in character as compared to the normal bone above it. That is, it was quite white and looked almost like ivory. With a rongeur a piece of this bone was chipped away and it was just as hard as ivory. After the surface had been removed there was a distinctly circumscribed plug of bone which was dense and hard which was separated from the normal bone by a fairly definite capsule of less dense bone.

The mass was removed in one piece and looked almost like a little plug of ivory inlaid in the bone. The remainder of the bone was apparently normal except that it was a little harder at the margins surrounding this dense bone. This hard bone was then drilled in two places with a small drill, opening into normal vascular bone above. The edges were smoothed off and the soft parts turned into the cavity, leaving the ligamentous attachments from the radius in the cavity.



FIG. 6.—Sclerosing osteomyelitis of carpal scaphoid.

*Pathological report by Dr. Elser.*—Specimen consists of a small ivory peg removed from the scaphoid bone. It is assumed that this is an instance of Garre disease, although a very unusual location for this type of lesion. The specimen is irregularly spherical in shape measuring between six and seven millimetres in diameter, also several small bone fragments. The peg is very hard to cut.

Histological section of one of the smaller fragments shows fairly normal bone. Sec-

tion of the peg-shaped piece shows very dense atypical bone. The lamellæ are irregular. Lacunæ are present but small and no marrow cavity is found.

The patient made an uneventful recovery. X-ray taken October 22, 1929, shows the process healed with a dense shadow in the involved area. Her pain has gone and the wrist is restored to full use.

### DIVERTICULUM OF ŒSOPHAGUS

DR. ARTHUR S. McQUILLAN presented a woman, age fifty, who was first seen in September, 1929, complaining of a choky sense in throat and a desire to clear same. Often regurgitation of food, especially liquids, and often a husky voice and sense of oppression in chest. First symptom was noted eight months previous, when she complained of regurgitation of a piece of chicken eaten one week previous. This lodgment of food in the



FIG. 7 —Diverticulum of Œsophagus. X-ray immediately following barium meal.

neck was the most annoying symptom and often the patient would press on left side of neck (just to left of trachea) to relieve this disagreeable symptom. Pressure in this area would cause a gurgling sound (as if air and fluid were escaping) and this could always be elicited by patient and examiner. Saliva could usually be made to regurgitate on pressure over this area.

Physical examination was negative with exception of pressure signs in left midpart of neck between trachea and sterno-mastoid muscle. X-ray immediately and one-half hour after swallowing a barium meal showed a rounded pouch of œsophagus situated on the posterior aspect towards left side; at level of second dorsal vertebræ. Outline smooth and regular. Inlet could not be visualized. No obstruction and no other deformities.

The woman entered hospital September 27, and was operated upon September 28, 1929, eight months after noting first symptom. The incision was along the anterior border of the sterno-mastoid muscle down through deep fascia overlying prethyroid muscles. The omohyoid had to be severed to obtain good exposure. By retraction of sterno-mastoid and carotid sheath

contents laterally, the thyroid gland and trachea medially, the space lateral to trachea and œsophagus was exposed. The œsophagus and diverticulum were easily identified, the diverticulum being situated just lateral to œsophagus and to the posterior half of trachea with fundus pointing down towards mediastinum. By careful dissection and traction on diverticulum, which was bound in position by loose areolar tissue, the pouch was easily freed and its neck, one-third the diameter of the fundus, was found to come off the œsophagus on its posterior aspect. The diverticulum was pulled into wound and its neck ligated near œsophageal wall with Pagenstecher, the ends left long so as to reach through wound in neck of patient. Another similar suture was attached to fundus of diverticulum and the ends left long for traction purposes. The diverticulum was then surrounded with rubber dam, and with a cigaretted drain on upper and lower sides, the wound in neck was

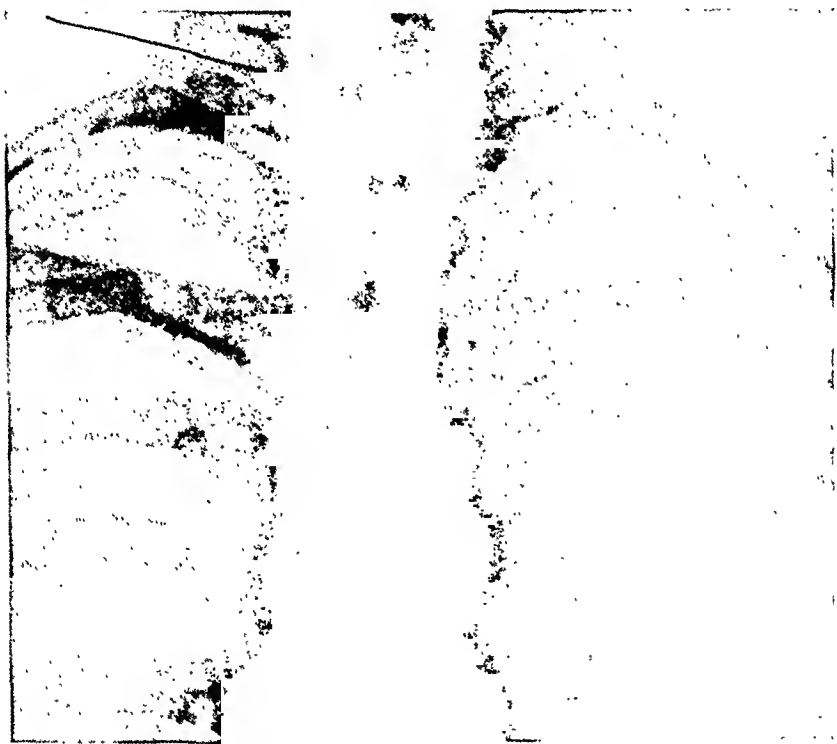


FIG. 8.—Diverticulum of Œsophagus. One-half hour after barium meal.

closed to drains. The whole procedure was simple and there was surprisingly little demand for securing hæmostasis. The time consumed was forty-five minutes and patient was in excellent condition at end of procedure. The most important structure to be kept in mind is the inferior laryngeal nerve which was protected to some extent by the thyroid gland.

*Post-operative Record.—First day.*—General condition was excellent with only slight sero-sanguinous discharge.

*Tenth day.*—The diverticulum on slight traction came away in one necrotic mass. There had been an offensive odor on one or two occasions. The patient was able to swallow liquid and solid food from the first.

*Tenth to Eighteenth day.*—The sinus gradually narrowed down. There was a moderate amount of leakage of liquid food which soon diminished in amount and completely stopped during the fourth week post-operative. At present time (tenth post-operative week) the sinus is practically closed, there being left an area of granulation tissue one-quarter inch in diameter.

DR. EDWARD W. PETERSON referred to his report, some years ago, of five cases of diverticulum of the œsophagus operated upon by the one-stage



method. One death in this series had convinced him that the two-stage operation was much the safer and wiser procedure.

DR. CHARLES GORDON HEYD stated that the consensus of opinion in regard to the operative treatment of diverticulum of the œsophagus was that the two-stage operation was the procedure of choice. The outstanding danger in manipulation of œsophageal diverticula was the development of infective mediastinitis. This complication could ordinarily be prevented with the two-stage operation. At the first stage identification of the diverticulum and its marsupialization allowed closure of the superior thoracic aperture and ten days later the diverticulum could be excised under local anæsthesia and the neck inverted. Doctor Heyd could not quite see the reason that Doctor McQuillan had placed a Pagenstecher around the neck of the sac. After this was done gangrene of the sac was an inevitable result and of necessity the wound in the neck must heal by granulation. If œsophageal leakage does occur after the second operation healing can be expedited by the introduction of a Levine tube through the mouth and nose and by means of the tube feedings may be maintained without leakage through the œsophageal fistula. In the second stage operation the recovery should be prompt and ordinarily recovery by granulation should not occur. Doctor Heyd showed some lantern slides demonstrating the technic of the two-stage operation.

DR. JOHN DOUGLAS also endorsed the two-stage operation. He showed some X-ray films of and a specimen from a woman he had operated on who for twenty years had shown all the symptoms Doctor McQuillan had described. Doctor Douglas saw her in May, 1928, but at that time she refused operation. Subsequently, her symptoms becoming more pronounced, she finally consented to operation which was done last June. The method of operation was that advocated by Doctor Heyd and, under local anæsthesia, the sac was freed very easily. Eleven days after the primary operation (reports from the Mayo Clinic recommend eleven to twelve days' interval) the sac was separated and excised, using only morphine and hyoscin. Novocaine was not necessary as the patient slept through the procedure. There were one or two points of interest, the first being in regard to Doctor McQuillan's statement that the entrance to the sac was posteriorly. It is always posteriorly in these cases in which the diverticulum occurs in the neck. The radiographer's report in the case here reported shows the entrance to the sac to be on the left side, but they always originate posteriorly. Another point of interest is the fact that in looking at this specimen one sees a very thick wall. One method of operation consists of invaginating the sac; if most of the cases had a wall as thick as this one no infolding could be done. There was another point of interest: This operation was done only six months ago, and the patient came to see Doctor Douglas recently in routine follow-up, although there was no return of symptoms, and he was able to pass a large bougie through the œsophagus to the stomach with no difficulty; but to prove she was well he had a röntgenogram taken which showed the

presence of a small pouch. So there is no certainty of complete cure in these cases and it would be interesting to see some röntgenograms of Doctor McQuillan's patient six months from now.

DOCTOR McQUILLAN, in closing the discussion, denied that he had meant to claim that his method had any great advantages over the usual two-stage operation, but he claimed that it is true that the wound heals by secondary union in this method. Healing *per primam* in the marsupialization method does not always occur as there is danger of infection in the second stage; also, two major operations are necessary to accomplish the same result. Doctor McQuillan agreed with Doctor Peterson, Doctor Douglas and Doctor Heyd that the one-stage operation for œsophageal diverticulum is too risky to be considered a safe procedure for if infection into the mediastinum occurs it is fatal. In answer to Doctor Heyd, the Pagenstecher was placed on the neck of the diverticulum close to the œsophagus in order to cut off circulation, so that the diverticulum would slough off at the end of ten days or two weeks. It is probable that at the end of two or three days enough adhesions are formed mechanically by the drains to wall off any later infection. The usual thickness of the diverticulum wall delays the necrosis. During the first ten days the discharge, only slight in amount, was of a serious nature and it was only after the sac had sloughed that there was œsophageal leakage for a short time.

#### GOITRE WITH ACUTE COMPRESSION OF TRACHEA

DR. ARTHUR G. McQUILLAN presented a girl whom he had first seen in April, 1927, when she was ten years of age. She was found to be in an extreme degree of dyspnœa and collapse. The thyroid gland was enlarged, one firm nodule in isthmus, one small one in the left lobe and another twice the size in the right lobe. Respiration was extremely labored and of the inspiratory type (expiration free and inspiration difficult). There was apparent obstruction to inspiration. Breathing was possible only in the sitting posture. She kept her head extended with chin elevated, giving the appearance of a stiff neck. She was afraid to recline or relax as in the reclining posture respiration became more embarrassed. She had had no sleep for a week except at intervals. There had been dysphagia for three weeks. The result was exhaustion and a loss of fifteen pounds weight. So great was the inspiratory pull that the lower chest flared with a groove three inches in depth, the latter noted by the parents only since the difficult breathing. There was acetone breath, marked cyanosis of face and finger tips, pulse 120, respiration 24 and temperature 100° F.

The child was said to have had a goitre for four years, noted in right side of neck. Two years later a similar nodule appeared in left side and a central swelling appeared during the past year. Trouble began in January, 1927, she began to have occasional obstructed breathing only on exertion and for the last six weeks continued obstructed breathing and dysphagia. There was a history of iodine medication with no results. The patient was born and bred in New York City, and the father was said to have had a goitre at the age of six and that it disappeared in the course of a year.

The child was taken to the hospital immediately and operated with only one object, to do a decompression and relieve respiratory obstruction. In the sitting posture and with novocaine infiltration anæsthesia, the thyroid

gland was exposed, showing a three-inch cystic nodule of the isthmus. While attempting to dislocate this, the patient fell back in syncope. In a hurried procedure, this cyst with four others surrounding the trachea was ruptured and respiration became easy. As nearly as one could tell, there was a systic nodule of the isthmus, two multilocular ones in the right lateral lobe, and posterior aspect of trachea, and two smaller nodules on the left lateral aspect. All were tense, wedging the trachea centrally and filled with fluid contents and degenerated soft thyroid tissue. There was a considerable amount of thyroid tissue posterior to the trachea. Thus the trachea was in the center of these cystic thyroid masses, which in turn were partly wedged into the space of the superior thoracic aperture. As inspiration would pull the trachea down, the mass of thyroid tissue completely surrounding it was wedged between the bony margin of the superior strait and the centrally placed trachea, resulting in partial collapse of the trachea and obstruction to respiration. Hence the effort on the part of the patient to keep her neck extended and chin elevated. On account of the grave condition of the patient, only a moderate amount of thyroid tissue was excised.

The patient made a good recovery and went along for about five months, when slight obstruction to inspiratory breathing was noted especially on exertion. This increased fairly rapidly. In January, 1928, (eight months following the first procedure), operation was attempted. Under ether anaesthesia with a No. 17 silk catheter in the trachea, with a funnel covered with gauze on proximal end of catheter, to facilitate the ether anaesthesia. The patient did poorly, so that at the end of thirty-five minutes' procedure, with considerable cyanosis and poor quality of circulation, it was decided to stop, with the result that only a three- by two-inch cyst, involving isthmus and right lobe of thyroid, was excised. There was some question as to whether or not the catheter went through the narrowed part of trachea. However the condition of the patient did not warrant further attempt of introducing the catheter. Following this operation the breathing became normal again and the patient made a good recovery.

Again she went on for a six-month period with only slight respiratory embarrassment on exertion, but from then on difficult breathing grew steadily worse, until in September, 1929 (nine months following the second operation), it became necessary to operate again to relieve the obstruction to breathing, which was becoming serious. This time a catheter was successfully passed through the tracheal narrowing. The thyroid tissue was so badly scarred and adherent to the trachea, that a subtotal thyroidectomy had to be done, leaving only about one-quarter of the right lobe in region of upper pole. The trachea was left free of thyroid tissue in its whole extent and it showed lateral flattening due to long continued pressure. Pallor and puffy eyelids, noted for several weeks following operation, have entirely cleared up at present time on thyroid feeding.

#### A CLINICAL STUDY OF CALCIFIED NODES IN THE MESENTERY

DR. HUGH AUCHINCLOSS read a paper with the above title for which see page 401.

DR. ALLEN O. WHIPPLE expressed the appreciation of the surgeons at the Presbyterian Hospital for this work that Doctor Auchincloss has originated. It had made them all believe that the diagnosis of calcified mesenteric lymph nodes should be differentiated from the lesions of the appendix. Doctor Whipple's own experience in these cases, including some of those

whose X-rays were reported by Doctor Golden, had been limited to eight cases, all in young women under thirty years of age and three in physicians' daughters. Two of the cases were observed for a period of five years before operation and showed progressive increase in the size of the deposits of calcium in the ileocaecal mesentery. Three of the patients were seen after a diagnosis of acute appendicitis had been made and the three were operated on later after the diagnosis of calcified mesenteric lymph nodes had been established. The other five cases were diagnosed as chronic appendicitis but



FIG. 9.—Multiple small and large, completely and incompletely calcified glands, overlying the right half of the pelvis. The large gland is still soft, with omentum adherent over it, and its contents are incompletely calcified.

later on the X-rays showed them to have chronic lymphadenitis. Two of these cases operated upon showed typical tubercles in sections under the microscope and this was confirmed when guinea pigs were inoculated. Doctor Whipple considered it striking that all these eight cases were in young women under thirty years of age.

DR. JOHN F. CONNORS said that fifteen years ago he operated on a child twelve years of age for appendicitis. She had pain in the right iliac fossa. At operation a normal appendix was found but in the ileocaecal region there were calcified lymph glands. Doctor Connors did not know just what they were but he felt they indicated a bad prognosis, so he sewed up the wound and told the father he was afraid she was doomed. He did not know what

the outcome would be but advised taking her to the country to live. This was done and the girl has remained healthy ever since. Two years after this experience Doctor Connors was called to see a doctor's daughter for appendicitis; at operation he found the same condition of tuberculous mesenteric glands. He gave the same advice as in the first case and this patient too has remained well.

DR. JOHN DOUGLAS asked if Doctor Auchincloss had any figures showing the percentage of occurrence of this lesion without causing symptoms. The speaker has had a few cases in which he has found enlarged lymph nodes and calcified lymph nodes in the ileocæcal region and in the mesentery of the small intestine and in one case he found some in the region of the duodenum. He was under the impression that in a number of these cases where shadows are found in the X-ray plates where examination has been made for gall-stones, or kidney-stones, the shadows are in reality due to calcified glands, particularly in those cases where it is very difficult to identify those shadows with the condition for which examination is being made. They are not always in the ileocæcal region. Doctor Douglas asked if Doctor Auchincloss could tell how many patients with positive X-ray findings are symptom-free, or in whom the symptoms cannot be linked up with the presence of shadows indicating the presence of calcareous glands.

DR. EDWIN BEER showed some pictures of a case similar to some of those of Doctor Auchincloss. At operation one of the glands as large as a walnut was still in a soft condition, full of calcareous material and there were omental adhesions attached to the gland which had perforated the mesentery. The material was full of lime salts and pus. There were no tubercle bacilli. Numerous other glands were solid and calcareous. In genito-urinary X-ray work the speaker sees a very large number of these shadows, some of which cause confusion, especially when renal colics are present. He had the impression that calcified glands never are associated with symptoms when they are hard and small in size, whereas the large, soft ones are apt to give more definite symptoms, due to adhesions, perhaps simulating appendicitis or adhesions or even ileus.

DR. ROSS GOLDEN (by invitation) said that in going over the literature a year or more ago he discovered some interesting information bearing on the question of the mechanism of infection of tuberculous mesenteric lymph nodes. Orth, the German pathologist, did some feeding experiments with calves before the identification of the tubercle bacillus which led him to the conclusion that the "poison" of tuberculosis was of the type that could pass through the intact intestinal wall. In 1890, Dobroklonsky, a Russian working in Paris, fed guinea pigs with a glycerine culture of tubercle bacillus. He made sections at varying intervals after the feeding. He found that the organisms very soon were present in the mesenteric lymph nodes, and proceeded to produce a typical tuberculous process. Some of his sections showed tubercle bacilli lying between the epithelial cells of the lining of the intestines and organisms were seen projecting from the intestinal walls into the lumen.

Other pathological and experimental evidence is present in the literature tending to confirm this same assumption; that is, that tubercle bacilli can produce a disease of the mesenteric lymph nodes without leaving any trace of their effect upon the intestinal wall.

X-ray examination was first recommended by Cornor, an English surgeon. In 1905 he reported a case of abdominal pain in a man of approximately middle age with a dense rounded shadow in the röntgenogram exactly overlying the right kidney. This was thought to be a kidney-stone. However, for some reason the pain was thought to be of nervous origin and the patient was discharged. The continuation of the pain, however, led to an exploratory operation at which a caseo-calcareous node about the size of a walnut was found exactly overlying the right kidney. It was curetted out and the patient had no more pain. In his second communication on this subject in 1909 Cornor again recommends X-ray examination as an aid to the diagnosis of tuberculous lymphadenitis. It is also mentioned by two or three German writers at this period. Apparently it is not mentioned again in the literature until 1926 when an article by Dunham and Smythe appeared. Doctor Auchincloss has described very nicely the X-ray appearances of these shadows. They may be very difficult to see if they overlies the spine. They may overlies the spine at one examination and not at another. If a patient breathes during the exposure the motion of the node may cause its flaky density to be blurred, giving it the appearance of a homogeneous dense shadow more like a kidney-stone. In one case such a blurred node shadow was misinterpreted as a kidney-stone and the patient submitted to an unnecessary operation. A film taken after the operation showed the shadow without motion and it was a typical calcified node. Node shadows have been seen apparently blurred by motion even though the patient apparently held his breath perfectly well. The only obvious explanation seems to be that the node lay near enough in the mesentery to the margin of the intestine to be shifted in position by peristaltic movements during the time of exposure.

In regard to the differentiation of so-called chronic appendicitis from the disease under consideration, the barium meal may give some helpful information. If the appendix is filled one can sometimes demonstrate that the tender point lies not over the appendix but medial to it or slightly above it. In some cases it has been possible to demonstrate that the tender point exactly coincided with the shadow of the calcified nodes.

DOCTOR AUCHINCLOSS, in closing the discussion, replied to Doctor Douglas with regards to the prevalence of these glands without symptoms, that this undoubtedly did occur in many instances; and in many other instances, though symptoms actually did exist, they were too mild to make the patient go to a doctor. The records in the British army showed that in a presumably healthy group of men calcified glands were found in about 25 per cent. These men presumably had high resistance and showed well walled off lesions. The statistics of Doctors Dunham and Smythe give a fair indication of their prevalence in children. Doctor Auchincloss stated that he did

not wish to give the impression that when calcified nodes were giving symptoms that the symptoms were necessarily due to the nodes, for several cases of acute appendicitis verified at operation have had calcified nodes. On the other hand, one finds great interest in those cases that present symptoms after the appendix has been removed, or some other operation done. It is very difficult to accurately estimate the proportion of cases where the symptoms are due to the calcareous nodes alone, but there was no doubt that such cases did exist. Doctor Beer's case showed a very typical picture with extensive involvement. Doctor Auchincloss was in doubt—how much more frequently large soft nodes gave symptoms, as Doctor Beer stated, than when they were small and hard. He did not believe the size of the nodes was the only criterion. In fact the patient presented before the Society this evening showed several small nodes that were pretty hard and had become calcified within four years' time. The little nodes may give symptoms as well as the large ones.

STATED MEETING HELD JANUARY 8, 1930

#### POLYPOSIS OF CÆCUM

DR. J. WILLIAM HINTON presented a young girl seventeen years of age, who was admitted to Bellevue Hospital, Fourth Surgical Division, October 9, 1929, on account of abdominal pain, loss of weight, and constipation alternating with diarrhoea. She had been operated upon in August, 1928, for chronic appendicitis in another hospital. She was somewhat improved by the operation but has never been entirely well. A complete description of the operative findings could not be obtained from the hospital but a verbal report from the operating surgeon was to the effect that the patient had ulcers of the intestine and chronic appendicitis, an appendectomy being done and no attempt being made to remove the ulcers of the intestine.

The patient stated that in April, 1929, she began to lose weight, had pain in epigastrium and constipation. She was put on a milk diet without any improvement and had various diets given for the next few months. In August, 1929, she had a gastro-intestinal X-ray series which was pronounced negative, although she continued to lose weight until four weeks before admission when she had an attack of diarrhoea which lasted for two weeks. This was followed by constipation. There was no history of cough, or night sweats, but she had lost thirty-five pounds in weight. She ran a septic temperature ranging from 100° to 103° while in the hospital. Chest examination was negative with negative X-rays. There was a mass in the right lower quadrant which was tender to pressure. Blood counts were normal. Leucocyte count 6,400 to 6,800, with polymorphonuclears ranging from 70 to 75 per cent. Wassermann negative. A gastro-intestinal X-ray series revealed the stomach and duodenum normal. Barium enema revealed a deformity of the ileum, cæcum and ascending colon. On October 22 she was transfused with 500 cubic centimetres of blood. October 25, 1929, under gas, oxygen, ether anæsthesia, the abdomen was opened through a right rectus muscle splitting incision. On opening peritoneum there was found a large mass which was the size of one's fist, in the right lower quadrant, the mass being attached to the parietal peritoneum in the region of the brim of pelvis. The mass was freed from the parietal peritoneum with only slight difficulty, and the cæcum, ascending colon and ileum easily delivered. The

## CHOLEDOCHOGASTROSTOMY FOR SCAR TISSUE OBSTRUCTION

mass gave the appearance of a tubercular infection of the cæcum which involved the lower ileum and ascending colon. There was no other evidence of involvement of the gastro-intestinal tract, and the peritoneum was normal. There were some enlarged mesenteric lymph glands. A typical Friedrich's operation was done, removing the lower six inches of the ileum, cæcum and ascending colon; and one-third of the transverse colon. The transverse colon was closed and then an end-to-side anastomosis was done, using No. 1 chromic gut for the anastomosis, taking three rows of sutures. Abdomen closed in anatomical layers, with small rubber tissue drain in the right lower quadrant.

*Post-operative course.*—The patient's convalescence was uninterrupted for the first five days, then she developed a fæcal discharge from the wound and this continued for four weeks. Her appetite returned within a few days following operation. She had a normal bowel movement daily and her temperature was normal after the first four weeks. She was discharged from the hospital December 6, with a granulating wound which was slightly infected.

*Pathological Report.*—(Doctor Symmers.) Macroscopic Examination: The specimen consists of the terminal 12 centimetres of ileum and the proximal 12 centimetres of cæcum, in one piece. The peritoneum covering the external surface of the gut is entirely normal. The mucous surface, on the other hand, shows two longitudinal ulcers, each measuring about 4 by 2 centimetres. The base of the ulcer is grayish red in color and finely granular. The mucosa at the edges of these ulcers is redundant and thrown into thick, bluish red, velvety folds and mound-like or actual polypoid masses. Of the latter, one is nearly 2½ centimetres in diameter and partially obstructs the lumen of the gut. Microscopic examination of the ulcerated areas shows the presence of simple ulcers, the bases of which are fairly rich in granulation tissue while the mound-like and polyphoid masses at the periphery of the ulcers are found to be made up of hyperplastic mucous glands. These mound-like and polypoid masses obviously represent an attempt on the part of the mucous membrane to regenerate itself in order to compensate for loss of substance occasioned by the process of ulceration. The lesion throughout is a simple inflammatory and regenerative one and shows no histological relationship to any of the granulomatous lesions, including tuberculosis.

*Pathological diagnosis.*—Mucous polyposis.

## CHOLEDOCHOGASTROSTOMY FOR SCAR TISSUE OBSTRUCTION OF THE COMMON DUCT

DR. J. WILLIAM HINTON presented a woman, forty-eight years of age, who was admitted to Post-Graduate Hospital June 25, 1929, on account of jaundice, itching of skin and pain in epigastrium for the past few weeks with increasing jaundice and itching. She had been operated on for an abdominal tumor in 1919, for a goitre in 1925, and a gall-bladder in October, 1928. She dates her present complaints back about four weeks when she noticed her skin getting yellow and she was bothered by some discomfort in epigastrium. No severe pain but an uncomfortable sensation in the upper abdomen, accompanied by belching of gas, without vomiting. Her condition gradually became worse and ten days before admission she was bothered with itching of the entire body, as well as increasing jaundice. In October, 1928, she was operated upon for a gall-bladder condition, after which she drained bile until the early part of January, 1929. Then the wound healed and she remained in fairly good health until one month ago when she began having epigastric discomfort and jaundice.

Report from previous operation at the St. Augustana Hospital, Chicago, Ill.—Stomach and duodenum normal. Gall-bladder green in color and



thickened. Enlarged glands along the duct, no stones palpated. Appendix, adhesions around the cæcum, subacutely inflamed. Uterus, normal in size and position. Adnexa in adhesions. Operation, cholecystectomy and appendectomy.

When admitted to the Post-Graduate Hospital she was thin and undernourished, with skin and sclera markedly jaundiced. She was twenty pounds underweight. Her neck reveals a scar from goitre operation but no evidence of thyroid enlargement at present. Abdomen, upper right rectus scar, firmly healed and also a lower midline incision firmly healed. Due to scratching from itching, she had numerous abrasions over arms, legs and body, with pruritus ani. Urinalysis negative. Bleeding time four minutes. Clotting time began five and one-half minutes, completed six minutes. White blood count and differential count normal. She was given daily hypodermoclysis 1000 cubic centimetres of 3 per cent. glucose, and 15½ grains of calcium chloride, intravenously, for four days.

July 3, 1929, her abdomen was opened through a right rectus muscle splitting incision, previous scar being excised. On opening the peritoneum, there were moderate adhesions in the right upper quadrant in the region of the gall-bladder bed, but the gall-bladder bed could be exposed without much difficulty, and the stomach was freely movable with duodenum adherent and definitely fixed. On exposing the common duct there was found a definite scar tissue obstruction one inch below the hepatics with a dilatation of the upper inch of the common duct, and both the hepatics. The common duct was opened and both right and left hepatics were probed and found to be patent. The common duct was definitely obstructed from scar tissue. The stomach could be easily approximated to the dilated portion of the common duct. It was impossible to approximate the duodenum to the common duct. A direct anastomosis between the common duct and stomach was done, the steps of which were identical to the steps of a gastro-enterostomy. After completing the anastomosis, three mattress sutures were taken from the stomach to the under surface of the liver to relieve any tension on the suture line between the common duct and stomach. A small rubber tissue drain was inserted through the peritoneum. Abdomen closed in anatomical layers.

The patient's convalescence was uneventful for the first few days. There was no leakage of bile around the drain until the fourth day when the patient saturated the dressing with bile. On the fifth day there was only very slight leakage of bile on the dressing, and on the sixth day it entirely disappeared. Cigarette drain removed on the sixth day, and from then on there was no leakage of bile. At this time it was noticed that the jaundice was definitely subsiding and the itching improving. The patient continued to improve and was discharged from the hospital on the twentieth day, at which time she was practically free from jaundice, and itching had entirely disappeared. The wound had healed with the exception of a slight area at the lower angle which was infected.

She was last seen November 11, 1929, at which time she felt perfectly well and was free from jaundice. She had gained eighteen pounds in weight since the operation.

The one reason for doing this operation was the ease with which the stomach could be approximated to the common duct for the anastomosis without tension on the suture line.

DR. SEWARD ERDMAN noted that Doctor Hinton in this case had been able to achieve the ideal condition of approximating a mucous lined surface to a mucous lined surface in repairing an obstructed bile duct. Considering

his own cases and those he had seen operated upon by others in the New York Hospital, he regarded it as unusual to be able to secure such exposure of the dilated portion of the duct that one could approximate it to the stomach. Other methods have been tried and have seldom proved satisfactory for any length of time, when dependent upon a tube of fibrous tissue. Often the case will do well for six or eight months, but it tends to contract down and then something further has to be done. Doctor Erdman considered that Doctor Hinton's ability to get a continuous mucous surface in this case should maintain the patient in perfect health indefinitely, as far as the common duct obstruction was concerned, and he believed that a report on this case in a year or two would prove this to be true.

DR. JOHN DOUGLAS referred to three cases of his own of post-operative stricture of the common bile duct. He had reported two of these cases in the ANNALS OF SURGERY in 1926. One of these patients called on him three weeks ago, suffering from rheumatism, and he learned that she had recurring attacks of mild jaundice, with slight rise of temperature, for two or three years after operation, but for the last five years she has been symptom free. The second case had recurring attacks for a few years after operation but has been symptom free for three or four years. Apparently the cause of post-operative symptoms after reconstruction operations in these cases was a residual narrowing of the duct because whenever they had recurrent attacks, a proprietary preparation of bile salts had tided them over the attacks of cholangitis by increasing the flow of bile, thinning it down and clearing out the infection. The third case referred to, which has not been reported, was a woman who had undergone a cholecystectomy at which time there had been perforation of the gall-bladder with abscess outside the gall-bladder from infection. The common duct was drained for some time and then healed up. A few months afterward she developed an obstructive jaundice. Doctor Douglas operated on her about three years ago with the expectation of finding dense adhesions but in fact found very few. It was very easy to find the dilated common duct. The obstruction in the common duct was low, lower than where the cystic duct comes off, for there was room to do a lateral anastomosis between the common duct and the duodenum which came in apposition very easily and the anastomosis never leaked a drop. She has remained well to the present time. When the operation can be done in this way the results are the most favorable, but in most of the cases the obstruction is very high up and at the junction of the hepatic with the common duct where such an operation cannot be done, and some form of tube anastomosis gives the best results.

Doctor Hinton, in closing the discussion, said that he also believed that it was only in a few cases that this operation could be done. The reason he undertook it was because as conditions presented themselves in the abdomen, the operation seemed easy and simple. In reviewing the literature he had seen reports of cases in which the left hepatic duct had been anastomosed to the stomach when the obstruction was high up in the common duct.

SEVERE GASTRIC HÆMORRHAGE TWO YEARS AFTER PARTIAL  
GASTRECTOMY FOR PYLORIC ULCER

DR. J. WILLIAM HINTON presented a man, thirty-one years of age, who was admitted to Bellevue Hospital, Fourth Surgical Division, December 1, 1929, on account of bleeding from rectum and vomiting of blood. The man began having pain after meals which would be relieved by taking food, in 1918. He was under the care of different physicians at that time and was placed on a diet. In 1923, not having been relieved of his pain, he entered Bellevue and had X-rays taken which revealed a duodenal ulcer. He was treated on a Sippy diet for two weeks at that time. He followed this diet with some regularity after that but continued to have pain.

He was admitted to the Fourth Surgical Division December 17, 1925, complaining of passing tarry stools for twenty-four hours, and bright red blood a few hours before admission. This was the first evidence of any hæmorrhage from the gastro-intestinal tract, although he had been home on a Sippy diet for two weeks before this admission. Also vomited blood after admission to hospital. Transfused the same day, with 700 cubic centimetres of blood. His abdomen was opened December 28, 1925. There was found on the anterior surface of the first portion of the duodenum, just beyond the pylorus, a crater-like ulcer about  $1\frac{1}{2}$  centimetres in diameter. A Finney pyloroplasty was done, using No. 1 chromic for the repair. He was discharged from the hospital January 1, 1926.

In April, 1926, he began to complain of pain in epigastrium, with a burning sensation. Had also lost six or seven pounds in weight. He had followed a Sippy diet regularly since his operation. X-ray examination April 22, 1926, revealed a small niche formation present at the site of the operative procedure, which suggested the presence of an ulcer in that region. He failed to return thereafter to the follow-up clinic.

January 8, 1928, he entered the Post-Graduate Hospital stating that he had continued to have pain since his operation. On January 9, he was operated upon and found to have a pyloric ulcer and a chronic cholecystitis. Partial gastrectomy was done, removing 13 centimetres of stomach, measured on the greater curvature. There was a crater-like ulcer of the pylorus  $1\frac{1}{2}$  centimetres in depth, with a lumen 5 millimetres in width. Cholecystectomy was also done. Pathological report revealed a chronic cholecystitis. He was discharged from the hospital January 24, 1928.

He now states that since this operation in January, 1928, he had been perfectly well, until a few hours before admission. On returning home from work he felt weak and dizzy and passed a tarry stool which was followed by red blood. He fainted and an ambulance was called, but before being brought to the hospital he vomited blood. He was transfused December 4, 1929, 500 cubic centimetres of blood being given. He continued to vomit blood for four days after admission. Transfused December 9, with 500 cubic centimetres of blood, after which he passed small quantities of blood in stools until December 18. Discharged from the hospital December 24, and is now under observation in the Gastro-Enterological Clinic.

ECHINOCOCCUS CYST OF LIVER THIRTY-THREE MONTHS  
POST-OPERATIVE

DR. J. WILLIAM HINTON presented a woman, twenty-seven years of age, who was admitted to Fourth Surgical Division Bellevue Hospital, March 8, 1927, on account of attacks of pain in right upper quadrant of abdomen with jaundice for the past eight years. According to her history about eight years ago she had an attack of pain in the right upper quadrant which radi-

## TREATMENT OF EMPYEMA AND LUNG ABSCESS

ated to the back and right shoulder. This pain was very severe. She has had several attacks a year since the first attack and has been jaundiced on a number of occasions. Between attacks she is bothered with belching of gas, sour eructation and heartburn. She states that during the attacks she has been jaundiced, her stools have been clay color. The last attack began eight days before admission when she had a sudden attack of pain in right upper quadrant which confined her to bed and she became jaundiced. This lasted only three or four days and the symptoms gradually subsided until the time of admission.

She was a well developed, nourished woman. Chest negative. Heart regular. The liver edge could be palpated just below the costal margin. There was a mass palpable in the right upper quadrant which was acutely tender with definite muscle rigidity on the right side. No other mass palpable in abdomen, no tenderness in right lower quadrant. No kidney tenderness. Temperature normal on admission.

March 9, 1927, her abdomen was opened through a right rectus muscle splitting incision. On opening the peritoneum a cystic mass, which was approximately the size of a large grapefruit, or even larger, was encountered which was adherent to the parietal peritoneum of the anterior abdominal wall. The mass was dissected free from the peritoneum, and it was found to involve the liver substance. On exploring the abdominal cavity the duodenum was found densely adherent to the mass which was dissected free. Only about one-quarter of the total circumference of the cyst was imbedded in the liver. The gall-bladder was found attached to the cyst but there was no evidence of stones in the gall-bladder and it was apparently normal. The cyst could be dissected out of the liver substance with very little difficulty and after doing so the cystic duct was easily exposed, clamped and divided, and the gall-bladder removed still remaining attached to the cyst. The cyst was not ruptured in removing same. The common duct did not reveal any evidence of stones. The hæmorrhage from the liver tissue was controlled by hot packs and the liver bed packed with iodoform gauze. No other cysts could be felt in either the right or left lobes of the liver.

Her convalescence was quite stormy for the first ten days, due to the destruction of liver tissue in removing the cyst. She began draining bile two days following operation and continued to do so for the next three weeks. On the fourteenth day post-operative, she developed an effusion in right chest which had to be aspirated on three occasions. Cultures were negative. The wound became infected and she had a partial separation of the wound ten days after operation. This gradually cleared up and the patient was discharged from the hospital June 13, at which time the right chest was entirely clear, and the wound was practically healed, and the patient had no complaints. Since leaving the hospital she has been seen in the follow-up clinic at regular intervals, the last visit being October 7, 1928, at which time she was perfectly well and had been since her operation. She was seven months pregnant at the time.

## TREATMENT OF EMPYEMA AND LUNG ABSCESS

DR. JOHN F. CONNORS presented three cases, two of empyema and one of lung abscess, illustrating the results obtained in sixteen cases so far treated by a method which he subsequently described.

CASE I.—A boy, fourteen years of age, was admitted to Harlem Hospital, November 28, 1929, with a diagnosis of pneumonia. On December 15, 1929, the chest was tapped and pus removed. Culture showed type 1 pneumococcus. On December 17 he was transferred to the surgical service.

On December 18 he was operated upon by the method to be described. In this case the time of dressings was changed to one every day for six days in an attempt to clean the cavity more quickly but it made no difference in the amount of the discharge, and for this reason the number of dressings was greater, this being the thirteenth, and there is now a very small amount of discharge.

CASE II.—Was operated upon November 11, 1929, and was discharged from the hospital December 6, 1929. The operation for empyema was performed following the method to be described. At the time of discharge the wound was entirely healed and has remained so since.

CASE III.—This patient was admitted to the medical service with a diagnosis of lung abscess. He was transferred to the surgical service and operation was performed August 12, 1929. When the parietal pleura was opened there was no collapse of the lung. After three punctures with a needle the pus was withdrawn from the left lower lobe about one and one-half inches from the surface. With the finger the normal lung tissue was penetrated into the abscessed cavity. The cavity was then packed tightly with washed iodoform gauze and the patient was returned to bed. Within forty-eight hours the foul smelling expectoration had almost stopped. This patient was packed twelve times and was discharged from the hospital thirty-one days after operation. The noteworthy factor of this case was that during the sixth dressing, on August 23, in removing the gauze the patient coughed and expelled not only the gauze but what appeared to be a cast of the abscess. From then on the wound remained very clean.

Doctor Connors said that in presenting these cases he was submitting for consideration the method of treatment and management of empyema cases as used by him at Harlem Hospital. Sixteen cases had been thus treated, but while the number is admittedly small, he had been sufficiently encouraged by the results to submit it to this society for discussion, criticism and suggestions for improvement.

Briefly the method is as follows: One hour before operation, the patient, if an adult, is given one-quarter of a grain of morphine and one-hundredth of a grain of atropine hypodermatically. The patient is placed on the table lying on the unaffected side, the arm of the affected side is placed above the head, thereby raising the scapula. The affected side is painted with iodine which is removed with alcohol. In adult cases a 1 per cent. solution of novocaine with adrenalin is used to infiltrate the line of incision. The incision is made over and parallel to the eighth rib in the posterior axillary line, and should be about four inches in length. About two inches of the eighth and ninth ribs are removed subperiosteally. In cases where there is a large flat rib only the ninth rib is removed. The pleura is opened by a stab with closed scissors. A piece of gauze is placed over the opening and after a short time the pleura is opened as widely as the incision will permit. The thin pus is then removed by a suction apparatus. The thick pus and the masses of fibrin, as is found in most instances, are removed by packing with plain gauze. This procedure may have to be repeated two or three times until the cavity appears to be free from fluid and fibrinous exudate. After this cleaning the pleural sac is carefully, thoroughly, and firmly packed with one and one-half inch washed iodoform gauze. In the average adult about fifteen yards of gauze is necessary for adequate packing. By adequate packing he meant the entire pleural cavity to be filled. The edges of the skin and muscle wounds are separated by packing tightly with plain gauze, thus fixing the muscles and skin as far apart as possible. If this is done there will be no excessive granulations in the wound and the subsequent dressings are much

less painful. He had learned from experience that the pain from these subsequent dressings is not from the pleural cavity but from passing the gauze over the raw surfaces between the skin and the cavity. The repacking can be made practically painless if there are two small retractors placed, one at the upper and one at the lower borders of the incision, about midway. In none of his cases had he found it necessary to use anæsthesia for the repacking, and in most instances after the second packing there is little or no discomfort experienced by the patient. Post-operatively, the patient is placed in bed in a semi-recumbent position and is encouraged to lie upon the affected side as much as possible. Morphine is used if indicated. At the end of three days the packing is removed and an X-ray is taken and the wound is repacked in the same manner but a lesser amount of gauze will be required at every subsequent dressing. The case is handled by changing the packing at intervals of two days until the wound is completely healed. A careful study of the expansion of the lung is made by X-ray. Pulmonary exercises by means of blow bottles are begun immediately after the first packing is removed, which encourages expansion. Fourteen of the cases thus treated were empyemas due to an infection with a pneumococcus, one was due to a streptococcus, one due to a pneumococcus in a patient with pulmonary tuberculosis. Eleven of these cases are entirely well. The first case was operated upon June 6, 1929, and has remained well ever since. He was seen in December, 1929, and has returned to his work. Four cases are still being treated and one case died two weeks after operation. This was the case of pulmonary tuberculosis. At the time of her death the operative wound was clean with a very small amount of discharge from the pleural cavity. No post-mortem was obtained. All of these patients were adults, except two. One was two years and three months old and, the other, this boy presented. In the two- and fourteen-year-old cases nitrous oxide and oxygen was the anæsthetic employed. In only one case was there any difficulty experienced when the pleura was opened. This case became dyspnoic, deeply cyanosed and the pulse rate rose from 110 to 140. He had a short jerky cough. The thoracotomy wound was covered with a piece of gauze for a few minutes when he suddenly expelled a large amount of mucus after which his respiratory distress cleared up. The amount of gauze used in these cases varied, in the adult the smallest amount being ten yards and the greatest amount twenty yards. The wounds were packed from six to twelve times before they were completely healed. In the two-year-old child a mistake was made for he was packed but three times and as his temperature remained flat he appeared well, had a good appetite, playing around the ward, when after eight days the temperature rose to 102, the pulse to 140. The X-rays showed that a small pocket of fluid was just above the closed sinus which necessitated a second operation. In another case, a young adult, the same condition arose. This will not happen again since his experience has increased. After the third or fourth packing the cavities were inspected by flashlight illumination and cystoscope and were all found to be clean and none of that thick, fibrous covering of the visceral pleura was in evidence. According to X-ray studies the subsequent expansion of the lung on the affected side progressed satisfactorily. No study of the tidal air changes was made. The condition of the wound at the time of discharge from the hospital showed that it was entirely healed in all but one case. This case had a small sinus and on X-ray a small pocket of fluid was found. The patient refused to have it removed but since that time he has returned and this small collection of fluid has disappeared. The period of stay in the hospital varied from eighteen to thirty-one days; the average stay being

about twenty-one days. At present there is a patient under treatment whose wound has been packed sixteen times but there is a complicating factor in this case of a gangrene of the pleura. On account of the odor it was deemed advisable to dress him almost daily. Doctor Connors believes that the advantages of this method of treatment are:

1. The opening in the chest wall is sufficiently large to allow complete evacuation of all pus and fibrinous exudate and later a thorough cleaning of the cavity.

2. Packing with iodoform gauze, which when properly done prevents the pocketing of pus, which has been the great trouble in the management of these cases. With the packing, adhesions are formed very early around the periphery of the packed cavity.

3. Secondary operations, if necessary, introduce no possible dangers of mediastinal flutter as there is an excellent fixation of the mediastinum.

4. It is in accord with sound surgical principles, namely, it affords adequate drainage of pus, producing sterilization of and obliteration of the cavity.

The question of mediastinal flutter may justly be raised, resulting from the production of an open pneumothorax when such a comparatively large opening is made into the pleural sac and death may occur from this cause alone. It is generally agreed that in empyema the mediastinum is fixed by adhesions, except those of streptococcic origin and the causes of death in the operative cases of streptococcic origin are laid at the door of mediastinal flutter which is not, in his opinion, the sole factor to be considered. In fact, death occurs in two groups of cases; in the first group death occurs at once while the patient is on the operating table or shortly after the operation and in this group of cases mediastinal flutter is a factor but collapse of the lung plays a large part in the dyspnoëic condition of the patient by the forcing of the contents into the opposite bronchus, thereby producing collapse of the opposite lung as is shown by the return to better breathing after expelling the bronchial contents. His conclusions of this type of case are based upon a rather large experience with open traumatic wounds of the chest. He was satisfied that the phenomenon of a flexible mediastinum does not adequately explain the situation. In the second group of cases in which death occurs in from four to thirty days after operation death is due to an improper evacuation and drainage of pus which produces a pyemia.

DR. JOHN DOUGLAS said that if Doctor Connors had a method of treatment of empyema by which he can get the patients well and able to leave the hospital in less than twenty-one days, it is better than any other so far as he knows. The object of treatment in empyema is the removal of infection, and drainage and sterilization of the cavity should be effected as soon as possible before the visceral pleura becomes thickened and prevents lung expansion. Doctor Connors' method certainly provides adequate drainage, and it would appear that he has found a way of lessening air pressure from outside so that the lung can continue to expand. Doctor Douglas also agreed that local anæsthesia should be used, instead of general, in all adult cases of empyema. Doctor Douglas believed that the shorter time in which private patients get well, than do the ward cases of empyema, is adequate proof that the after-care is almost as important as the primary operation; perhaps the shorter time in Doctor Connors' cases is due to his having taken care of them himself because of his especial interest in this series. Regarding the choice



between the two methods, the open and the closed, Doctor Douglas believed the closed method with Dakin's irrigation, using the two-way tube, offers advantages over the open method, and he also believed this method of Doctor Connors' had an advantage over the old open method. The speaker asked Doctor Connors two questions: one, whether there had been any signs of iodoform poisoning or any bad effects from using so many yards of iodoform gauze in the packing of these cases. Of course in some cases this is due to an idiosyncrasy, but there have been severe cases of poisoning which resulted from simply using iodoform on an infected finger, a marked rash and swelling extending up the arm, and even cerebral symptoms have developed after the use of a very small quantity. Doctor Douglas used iodoform gauze with caution; even in resection for carcinoma of the rectum where there was a large cavity in the pelvis, he supplemented the use of it with plain gauze. The second question was: in the case of lung abscess did Doctor Connors penetrate to the abscess through normal pleura in a one-stage operation, without any attempt to block off the pleura?

DOCTOR CONNORS, in reply, said that in the entire series of cases there had been no symptoms of iodoform poisoning; this was probably due to the fact that the gauze was always washed before insertion into the cavity. He agreed thoroughly with Doctor Douglas as to the value of the after-care as a factor in securing the earlier cure of these cases. There were no signs of mediastinal flutter in any of the empyema cases. They were carefully watched and the only change observed was a gasp-like inspiration at the moment the chest was opened. There was a rise in the pulse rate and a cough which lasted only a minute, after which the patient seemed to experience no untoward effects. In the case of abscess of the upper lobe of the lung there was some flutter which interfered with the pulse and respiration, so much so that it was necessary to resort to the use of oxygen, but after forty-eight hours recovery was uneventful. The later cases have been done with the patient placed in almost a sitting position and with these cases there has been less difficulty than with those lying flat on the unaffected side.

#### THE CAUSES OF DEATH AFTER OPERATION. A STUDY BASED ON EIGHT HUNDRED AUTOPSIES

DR. HAROLD NEUHOF read a paper with the above title for which see page 321.

DR. HOWARD LILIENTHAL said that the number of autopsies in this series, eight hundred, was impressive, and he felt that any mistakes that might have been made in Doctor Neuhof's analysis was counterbalanced by the size of the collection of cases which has been studied so carefully. Excluding the forty-eight hour ones was generous for the speaker knew that some of them had died of suppuration, or of an infection which would have gone on to suppuration. (By the by, it was noticeable that Doctor Neuhof had avoided using the word "infection.") A patient may develop violent erysipelas and die in forty-eight hours; all surgeons had seen this happen. In



Table IV, the Genito-Urinary Table, it was astonishing to see no record of deaths from pneumonia in the suppurative cases; this was the more remarkable because deaths from pneumonia in non-suppurative cases were recorded. Possibly the explanation is that the suppurative cases did not live long enough. Regarding Table VI, Exploratory Laparotomy, Doctor Lilienthal was not certain what Doctor Neuhof meant by the term "exploratory laparotomy," in this study. The speaker had always regarded the procedure as uncertain and dubious; Dr. Morris Manges had once said that exploratory laparotomy was among the most dangerous operations of surgery. If one opens the abdomen and nothing is found, the operation is rarely severe and it is doubtful if such patients would die of pneumonia or sepsis in large numbers. If a so-called exploratory operation is done and it is found that there is a pathological condition to be relieved, it is no longer an "exploratory" procedure. It was in regard to the bad cases where exploratory operation had to be done that Doctor Lilienthal was in doubt; Doctor Neuhof had listed 21 per cent. of what the speaker regarded as suppurative cases in which death had followed "exploratory" laparotomy.

Doctor Neuhof's general classification seemed very fair; there are some cases in which death can occur from infection but other causes are also present. Doctor Neuhof had not considered diseases of the chest, such as tuberculosis, where other dangers besides suppuration threatened. Thoracic surgery should be included in a study of this kind for more and more work was being done in this field.

As to the lesson to be learned from this essay, the most important was that lives can be saved if during the post-operative period one looks for the most natural thing that might cause death, and that has been shown by Doctor Neuhof to be suppuration. Consequently, when things are not going well in cases that ought to be doing well, look at the lungs and look for suppuration. When an automobile fails on the road one looks in the gas tank first.

DR. RICHARD LEWISOHN said that there seemed to be a doubt among surgeons as to what one could really call a clean case and what one could call an unclean case. A hernia, a goitre or a brain tumor must be regarded as a clean case. The speaker would not regard as a primary clean case an operation on the bladder, or on the gastro-intestinal tract where an opening must be made into a gut containing infective material and where the surgeon lays the patient open to infection, because there can be no adequate protection. Doctor Lewisohn did not think one could regard such a case as a clean one from the standpoint of possible surgical infection. Everyone knows that in former years the importance of peritoneal infection was under-valued and in case of death the chest was accused. A leading surgeon once said that if there was no post-mortem on a case of death following an abdominal operation it would always be ascribed to pneumonia. Doctor Lewisohn believed that it was very important that Doctor Neuhof had found peritoneal infection to be so often the cause of death after laparotomy. The speaker had occasion many years ago, when he was an assistant in Doctor Czerny's

clinic, to look up the causes of death in patients suffering from post-operative pneumonia from 1901 to 1905. He found that in 50 per cent. of the deaths where post-operative pneumonia was found at the post-mortem examination, the post-operative pneumonia had been caused by an infection in the abdomen spreading up through the diaphragm. Doctor Neuhoof has gone a step farther and has shown that in many cases one is not dealing with pneumonia at all, but with a suppuration in the operative field. As to Doctor Lilienthal's hope that if one can make the diagnosis of peritonitis early enough, re-operation can cure the patient, Doctor Lewisohn doubted if that were so. Secondary operations can cure the patients in the presence of a well-localized abscess. They fail to effect a cure in the presence of a spreading peritonitis without localization.

DOCTOR HYMAN expressed surprise to see in Table IV, the Urological Section, that in a series of fifty-five deaths, 44 per cent. were due to post-operative suppuration in the upper urinary tract. He believed that one would be apt to get an erroneous opinion from this. Doctor Neuhoof, in reading the paper, had changed the nomenclatures "infective" and "non-infective" to "suppurative" and "non-suppurative." One could get the idea from the paper that 44 per cent. of the non-infective urological cases died of suppuration in one form or another. Of course, it comes down to the question just where to stop in saying a patient is infected or not. Practically all the prostate cases are infected. The speaker had an opportunity to see the work sheets of this table. Prostatic adenoma, carcinoma of the bladder or vesical calculus, and so on; at least 95 per cent. of them are infected cases. One rarely sees clear urine in prostatics coming for operation. In talking this over with Doctor Neuhoof he said that he wanted to get away from the words "infected" and "non-infected," but confusion as to these terms is likely to lead to error in considering the upper urinary tract. The kidneys and ureters are generally not catheterized prior to operation in this type of case and one cannot therefore tell the degree of infection present before operation. Two of these cases of prostate adenoma showed at autopsy an infected kidney and hydroureter. This condition was surely present at the time of operation. Doctor Hyman said that what he wanted to bring out was that, according to this classification, an erroneous idea as to the frequency of suppuration as the cause of death in non-suppurative urological conditions may be obtained. The cases do die of suppuration, but in 80 or 90 per cent. a primary suppurative condition has existed in the urinary tract before operation.

DR. JOHN DOUGLAS referred to one point in Doctor Neuhoof's tables that had not yet been discussed: in 204 deaths in non-suppurative cases, 39 per cent. of the deaths occurred from suppuration. Also, in 50 per cent. of the cases which died of suppuration, suppuration was not even suspected as the cause of death, according to another table. Doctor Neuhoof had also called attention to the fact that although the ante-mortem diagnosis of pneumonia was made in a considerable number of cases, in only 60 per cent. was the

diagnosis of pneumonia confirmed, so that in 40 per cent. it was wrong. The diagnosis of intra-abdominal suppuration depends on the symptoms of local tenderness, localized pain and rigidity. Some patients are very sick, have no rigidity, the pain is not local, and they are tender all over or too sick to be tender enough for diagnosis; they often have a chest condition, due to cardiac failure or a hyperstatic congestion which it is difficult to differentiate from pneumonia. In such cases, how can one make a diagnosis of suppuration? The question is, what of greatest importance can be learned for the benefit of such cases from this presentation of Doctor Neuhof's? In the speaker's opinion the presumptive evidence would be, in these cases that are going badly, that they have infection and suppuration; if it is localized, there may be a chance to do something, and if it is general, they will die anyway.

DR. LEO MAYER (by invitation) presented a report which he had prepared showing the cause of death in ten orthopaedic cases—all bone and joint cases. Of the series there was only one in which there was frank suppuration. One death was from tuberculous meningitis following a fusion operation on the spine; four died of acute septicæmia following acute osteomyelitis; one died of pulmonary embolism; three died following malignant growths; and one died of acute suppuration following arthroplasty of the knee. It would, therefore, seem that the figures in orthopaedic surgery were not in accord with those of surgery of other parts of the body.

DOCTOR NEUHOF, in closing the discussion, answered Doctor Lilienthal's question as to what was meant by exploratory laparotomy by stating that this comprises a group of cases in which at operation the patients were found to be suffering from an irremovable neoplasm and upon whom nothing further was done than exploration. There were some chest cases in this series of 800 in which thoracoplasty was done for pulmonary tuberculosis, but these patients have been classified as having died of their original disease, *viz.*, tuberculosis. As to the nomenclatures "infected" and "non-infected" *versus* "suppurative" and "non-suppurative," this is not of great importance; Doctor Hyman was correct in stating that the speaker had previously used the first mentioned terms. As a matter of fact he had changed the nomenclature a number of times, but had finally come to the conclusion that "suppurative" and "non-suppurative" would be more inclusive as these terms would embrace some of the doubtful cases. As Doctor Lewisohn said, it is important to know when a case is "clean," and this is a subject that has been discussed pro and con at many surgical conferences without having been finally settled. In this series, if a patient were an interval case and had died after the operation, say from appendicitis in which the appendix had been found to be not acutely inflamed, the case was not placed in the suppurative column. In a similar way the urinary cases have been classified; most of them were prostate cases. When death was ascribed to suppuration the evidence had to be clear that the suppuration was recent if the case were to be classed as death from suppuration.

# BRIEF COMMUNICATIONS

## THE VALUE OF SPALTEHOLZ CLEARING METHOD IN THE STUDY OF SURGICAL AND PATHOLOGICAL SPECIMENS

THIS communication has been prompted by many inquiries as to the technic of preparing large cleared sections of tissue for study in our laboratory of surgical pathology.

The Spalteholz method which renders tissues transparent has long been of inestimable value in experimental work. Its application in the field of pathology and as an adjunct to teaching was first suggested by a study of the beautiful and instructive histological sections of whole breasts prepared by Sir Lenthal Cheate.<sup>1</sup> These were given to us for teaching purposes some years ago and lacking the equipment for their preparation we resorted to the Spalteholz clearing method.

The original Spalteholz technic of fixation by formalin has been described by Sabin<sup>2</sup> with an added modification of Carnoy's fluid used as a

fixative in her work on mammalian embryos. The essentials of the Spalteholz method are, "first, fixation in formalin; second, a thorough bleaching of the tissues with hydrogen peroxide to remove the hæmoglobin and other pigments; third, dehydration; and fourth, clearing the specimens in an oil which has the same index of refraction as the tissues." Ordinarily a considerable amount of blood is removed in the handling of fresh specimens and what little remains after clearing serves to identify the blood vessels at a glance. Complete removal of the hæmoglobin may be accomplished by bleaching the fixed specimen in undiluted hydrogen peroxide, the time required being from fifteen to thirty minutes. "Following the bleaching the specimen must be washed thoroughly in running water and in distilled water. The dehydration may be begun with 50 per cent. alcohol and the percentage increased successively by five points or less. After two changes of a good grade of absolute alcohol, the specimens are passed through two changes of benzene into the synthetic

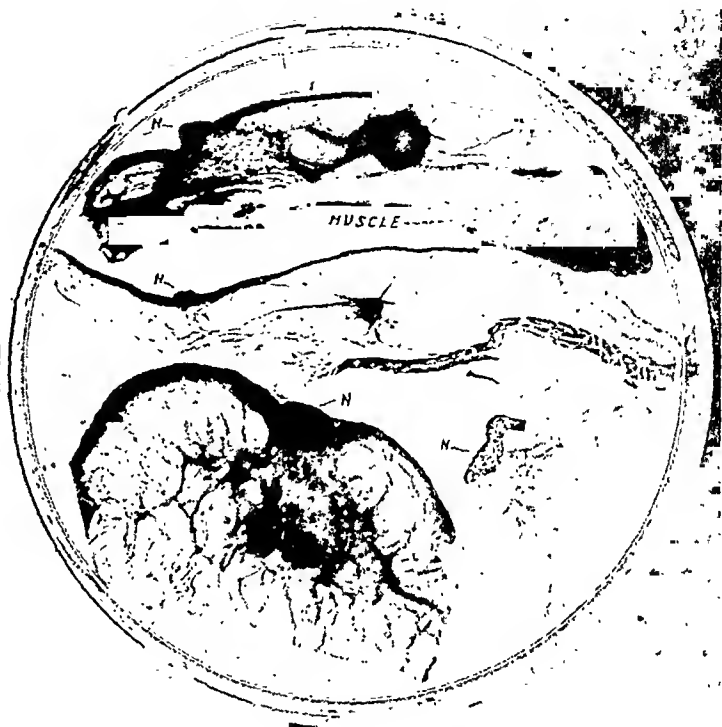


FIG. 1.—Photograph by trans-illumination of four cleared specimens of mammary carcinoma. The upper specimen is two centimetres in thickness. N indicates nipple.

oil of wintergreen. The small amount of benzene which is carried over evaporates quickly, and the few bubbles which develop in the bleaching process can be removed with needles. The oil of wintergreen should be entirely colorless but both the specimens and the oil will gradually become brown with age," and should be protected from sunlight. "They can be returned to alcohol for storage and recleared when desired or they may be made permanent in balsam." Keeping them in the oil of wintergreen so toughens the tissues that they can be dissected under the low- or high-power binocular microscope.

Microscopic study of these cleared specimens is best made by submersion in oil in a flat glass dish beneath which is a substage lamp or frosted electric light globe, thus transilluminating the tissue. For histological study any portion of the specimen can be removed with a safety razor blade, passed through a mixture of oil of wintergreen and paraffin, and then embedded in paraffin for section.

Routine pathological studies are of course always made on other portions of the fresh specimen.

Sabin's use of Carnoy's mixture for fixation has further simplified this method. The mixture "is absolute alcohol 60 parts, chloroform 30 parts, and glacial acetic acid 10 parts. In this mixture the acid is sufficiently strong to bleach the hæmoglobin so that the peroxide is unnecessary. The penetrating power of the fixative is very great. . . . The relations of the tissues are well maintained and the swelling due to the acetic acid tends to counteract the shrinkage that always takes place in the oil of wintergreen. The fixative does not affect any of the injection fluids. The process after fixation in the Carnoy's mixture is simple; the specimens remain in the fixative from 2 to 12 hours and are then placed directly into 70 per cent. alcohol, dehydrated in graded alcohols, and cleared as before."

With very large specimens it is sometimes better to take the fresh material obtained from the operating room or at autopsy, freeze it in its natural shape by placing it in a refrigerator plant and then cut sections of from 0.5 to 2.0 centimetres in thickness, which on thawing are placed in a fixing solution and then cleared.

The accompanying photograph (Fig. 1) of four specimens of mammary carcinoma was made by transillumination. The transparency, the thickness of the specimens (0.5 to 2.0 centimetres) and the finer details are poorly shown but can readily be seen in their three dimensions with the naked eye or with a binocular lens. These four specimens were obtained by cutting through the tissue removed in a radical amputation of the breast so as to pass through both the tumor and the nipple (N). Two of the specimens show the malignancy beneath the nipple, the others show the carcinoma as more circumscribed and of varying characteristics at some distance from the nipple. The fatty tissue has become so transparent that it sharply outlines the fibrous and cancerous tissues and clearly reveals the spread of the malignant cells.

These whole breast sections afford a visual picture of great value in the

study of tumors, and of their influence on the skin, the breast tissue and the underlying muscle. Frequently three or four such sections, 2 centimeteres or more in thickness, suffice to present the entire tumor process surrounded by transparent breast tissue. The method has been extended to material other than from the breast and is useful in the study of specimens from the brain, lungs, intestinal tract and integument. These specimens serve as a permanent mount in the museum and have also been of great value in our teaching.

## CONCLUSION

The Spalteholz clearing method and Sabin's modification require no special apparatus and offer a simple and satisfactory technic in the preparation of surgical and pathological specimens.

By their transparency these specimens provide for further study of tumors and disease areas in relation to the surrounding structures.

In conjunction with histological preparations several such sections suffice to convey a complete picture of a given pathological process and are of inestimable value in teaching.

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## DOUBLE GALL-BLADDER

THIRTEEN years ago Dr. August Schachner<sup>1</sup> of Louisville, Kentucky, reported a case of a double gall-bladder (ANNALS OF SURGERY, October, 1916).

I desire now to place on record another case similar to the one presented in his paper. In an exhaustive study of the literature I have been able to find to date only seven cases of double gall-bladder reported. The specimen now described was shown at last year's meeting of the American Gastro-Enterological Association, at Washington, D. C., and brought forth considerable comment because of its rarity.

In a consideration of congenital anomalies of the liver and gall-bladder it has been stated that two livers in a human being is the rarest condition, there being only one such case on record. The next rarest anomaly is reported as being absence of the gall-bladder and all ducts, with thirteen cases being reported. This being true, then absence of the gall-bladder and all ducts is not the second rarest anomaly but rather double gall-bladder is the second rarest, inasmuch as only seven cases have been reported, this

case being the eighth. This would place the third rarest anomaly as absence of the gall-bladder and all ducts. The next, or fourth rarest anomaly is absence of gall-bladder, cystic and common ducts, with fourteen cases being reported, and next, or fifth rarest is absence of gall-bladder and cystic duct, there being thirty-one cases reported. True left-sided gall-bladder has been reported many times.

Double gall-bladder in animals has not been very often reported. Double gall-bladders with separate cystic ducts has been reported in two young rams.<sup>2</sup> In each case the gall-bladder was as large as usual and the chambers were separated by septa of connective tissue. In one case, the both chambers were equal in size, while in the other case, the one chamber was only half the size of the other. All chambers had bile and there were no liver anomalies. A similar condition was also reported in a five-year-old ox where one chamber was only one-fourth the size of the other and where the septum was perforated, allowing an intercommunication.

Doctor Schachner's case<sup>3</sup> in the human had two unequal chambers with separate cystic ducts and stones in each side and in this respect was similar to the case here reported.

Dr. Benjamin W. Rycroft, of Beacon House, Bradford, England, very kindly forwarded me a diagram illustrating his case<sup>4</sup> of Bilocular gall-bladder. Examination of this sketch reveals the fact that his case was not one of complete double gall-bladder inasmuch as the septum extended from the fundus only three-fourths way down to the neck of the gall-bladder. There were twelve calculi present in this gall-bladder.

Professor C. F. Van Oyen, of Utrecht, forwarded me a description of the case reported by Dr. C. DeGraaf<sup>5</sup> in which the patient had two distinctly separate gall-bladders and two separate cystic ducts, each one centimetre long, which united to form one cystic duct.

H. Critchley Hinder, M.B., Ch.M., Hon. Surgeon, Royal Prince Alfred Hospital, Sydney, Australia, reported a case<sup>6</sup> wherein the septum extended half way up the fundus from the neck exactly opposite to the position of the septum in the case reported by Doctor Rycroft. This latter case also had stones in both loculi. Those interested in the anomaly would do well to consult his paper.

CASE REPORT.—Mrs. B. F., aged thirty years, was referred to me at the Locust Mountain Hospital, April 15, 1928, by Dr. Ivor D. Fenton, of Mahanoy City, because of severe pain in the upper right quadrant of the abdomen. Her temperature, pulse and respiration on admission was 99-98-20. The first attack was seven years ago accompanied by a chill and weakness and she had many attacks in this interval. Her pains were not intermittent and always lasted until a hypodermic of morphia was given. These attacks were usually at night and the interval of time between attacks became less toward the end. Patient states she was extremely hungry for all foods all the time but could not eat when food was placed before her.

The last attack of pain was intermittent, started three days ago, and the patient had chills with nausea and vomiting each of these days. The early history of the patient added nothing to the diagnosis, although it might be here stated that on examination, a positive blood serology was found.

The head, mouth, and throat were normal; there was no jaundice, and the lungs were clear. The heart sounds were of good quality and murmurs were not heard. The abdomen was tense and there was rigidity over the upper right rectus. Murphy's sign was positive; no masses were palpable, and Carnett's both A and B tests for neuralgia of the abdominal wall were negative. She was admitted with a tentative diagnosis of cholelithiasis.

Iodeikon was administered intravenously that evening for visualization of the gall-bladder and the X-ray report by Dr. P. B. Mulligan was as follows:

"No gall-bladder shadow was evident on any of the films of this series. There is, however, a shadow opposite the second and third lumbar vertebrae which is about the size of an English walnut and which has much the appearance of being one large gall-stone."

I operated upon the patient April 26th. When I attempted to isolate the cystic ducts, I found two of them, each of which I ligated separately. I was impressed with

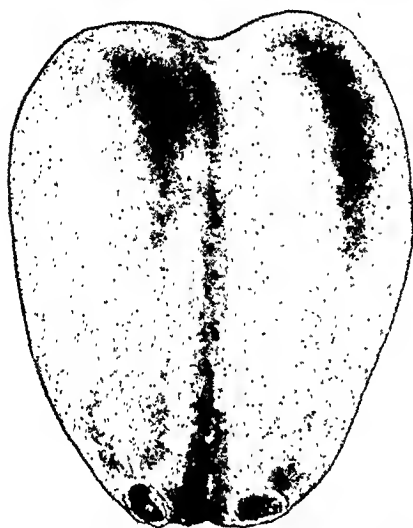


FIG. 1.—Double gall-bladder showing serosal surface and depression or ridge of the septa and beginning of each separate cystic duct.

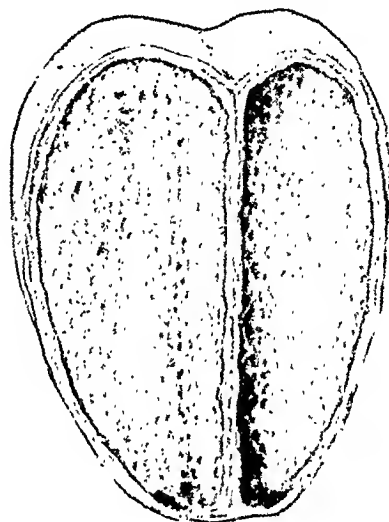


FIG. 2.—Double gall-bladder specimen divided sagittally, showing strawberry mucosal surface. Note exit of each cystic duct and septum.

a hard white ridge extending upward on the gall-bladder and in view of the fact that I had two cystic ducts, became suspicious that there was a septum present in the gall-bladder. This proved to be true. Each side was tensely full of bile of the B type and there were numerous small stones present in each chamber and one very large stone in one of the chambers.

The gall-bladder was removed *in toto* and a soft slit rubber tube and wick inserted. She made a very rapid convalescence and was discharged from the hospital May 15, 1928. Follow-up reports from her family physician state that she is enjoying very good health and has had no further trouble.

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## BOOK REVIEW

STONE AND CALCULOUS DISEASE OF THE URINARY ORGANS, by J. SWIFT JOLY, M.D. 8 vo.; cloth; pp. 555; illustrations, 193. C. V. Mosby Co., St. Louis, Mo., 1929.

Extraordinary as it may seem, there has been no book published during the past twenty years which has been devoted exclusively to the question of urinary calculi. Certainly the chapters devoted to its consideration which appear in books on general urology and more particularly in general surgery must necessarily be abbreviated and but in a small measure represent the numerous and varied phases of the subject in its entirety.

In the present volume, the subject matter is presented in a peculiarly readable form. The introductory chapter on the history of urinary lithiasis is of the greatest value to any practitioner and most interestingly narrated. The succeeding chapters on the general characteristics of calculi and their etiology are complete in their detail and will repay the perusal of any physician in general practice as well as of one devoting himself to this specialty.

In the consideration of renal and ureteral calculi, the author continually emphasizes the necessity of conservative surgery and considers each debated question in such detail that its merits are readily appreciable. A most instructive consideration of the medical treatment, prevention, non-operative and post-operative, is included. The topic of differential diagnosis is excellently handled. It is interesting to note the omission of the occurrence of torsion of the kidney (Dietl's crises) in this connection.

Plastic operations on dilated pelves, a procedure which has received impetus lately, is not taken up and might well be included. The author's preference for the lower median incision for exposure of the pelvic ureter in extraperitoneal ureterotomy rather than the lateral, is noted and its consideration is well worth while studying.

The alarming complication of calculous anuria and the indications for operative or non-operative interference is a most important inclusion in the present work and analysis of it will repay both the urologist and the general surgeon.

Certainly the revolutionary methods of investigation of the genito-urinary tract for disease chiefly by the use of radiography, cystoscopy and the application of the recent advances in physiological chemistry have necessitated a complete revision of our knowledge of procedure in these conditions and the author has succeeded admirably in presenting the subject in its entirety in a most attractive way.

JAMES T. PILCHER, M.D.

# MEMOIR

FRANCIS JOHN SHEPHERD, M.D., C.M., L.L.D., F.R.C.S.

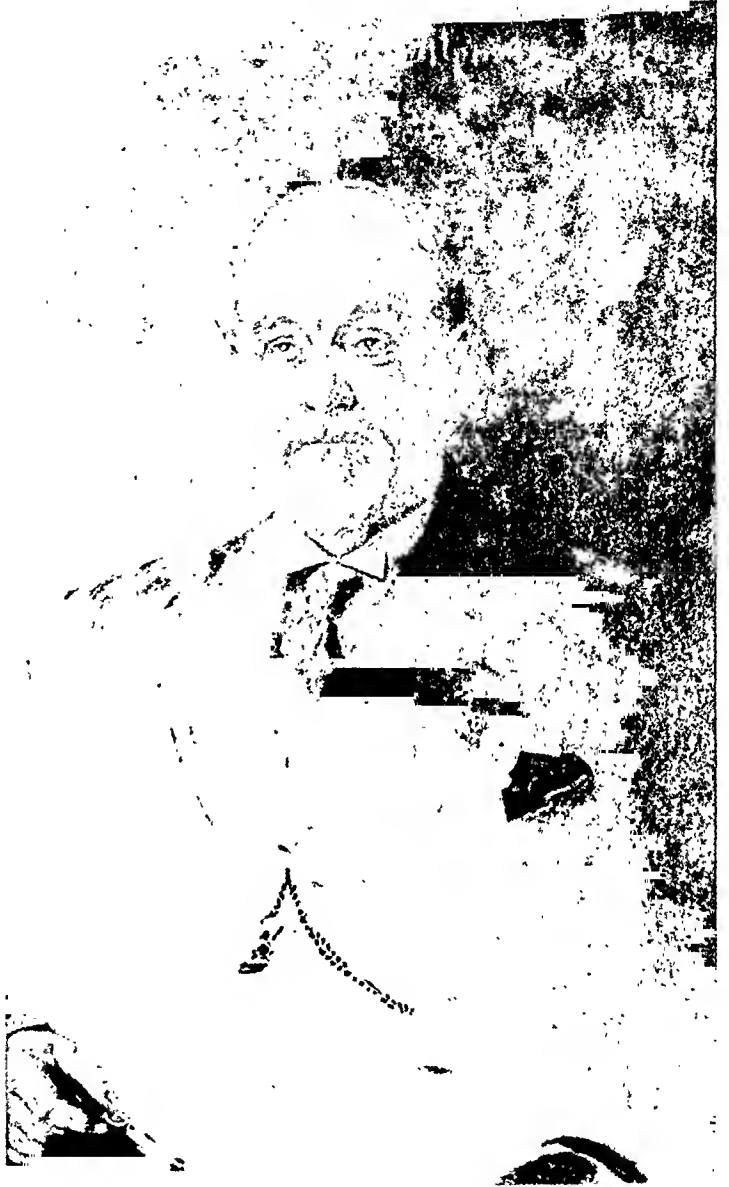
1851—1929

FRANCIS JOHN SHEPHERD was born at Vaudreuil, near Montreal. His early education was received at the Montreal High School, followed by a year in the Arts Faculty of McGill University before entering the Medical Faculty from which he graduated in 1873. He then went abroad for further study in London, Paris, and Vienna. In the latter city he was joined by William Osler who had graduated from McGill the year before.

Two outstanding features of this trip were his concentration on anatomy and the methods employed in teaching anatomy in England and on the Continent, and his interest in dermatology. He took a course under Hebra and gave special attention to dermatology throughout his professional career.

On his return to Montreal he was appointed Demonstrator of Anatomy in the Medical Faculty of McGill University and, on the death of Professor Scott, was made full pro-

fessor and occupied the chair for thirty years. Under his direction the teaching of human and comparative anatomy attained a very high standard. He gradually assembled in the Anatomical Museum a large and rare collection of anatomical anomalies which, unfortunately, was lost in the fire that destroyed the building in which they were housed. Many of the most brilliant and successful teachers in medicine and surgery and the specialties in McGill received their early training and inspiration from Doctor Shepherd.



FRANCIS J. SHEPHERD, M.D.

As Demonstrator of Anatomy, Doctor Shepherd organized a clinic in dermatology in the Montreal General Hospital in which he took great interest.

As a surgeon Doctor Shepherd was a most careful and conscientious diagnostician and operator. He established a Summer Session at the Montreal General Hospital which he carried on for many years.

His contributions to surgical literature were numerous. He was for many years on the Editorial Board of the Montreal Medical Journal, and contributed a monthly review of surgical publications, terse, critical and sometimes humorous. These were afterwards published in book form. He was the author of the article on the "Thyroid" in the *American Practice of Surgery*; joint author of *American Text-book of Surgery*; and contributed articles on Anatomy and Dermatology for Wood's *Reference Handbook of the Medical Sciences*. He was President of the Montreal Medico-Chirurgical Society in 1900 and President of the Canadian Medical Association in 1901.

Doctor Shepherd's character and scientific work were very widely recognized. He was an Honorary Fellow of the Royal College of Surgeons, Edinburgh, and a Doctor of Laws, Edinburgh University; L.L.D. Harvard, 1906; L.L.D. McGill, 1915; and L.L.D. Queen's, 1919. He received the Honorary Fellowship of the Royal College of Surgeons in 1913 and Honorary Fellowship of the American College of Surgeons in 1914. He was corresponding member of the Société Internationale de Chirurgie de Paris, and foreign member of the American Academy of Arts and Sciences. On his attaining his fiftieth year after graduation, he was tendered a banquet by his former house surgeons and demonstrators of anatomy, and presented with a fine piece of Georgian silver. The following year his numerous friends in the profession presented him with a portrait of himself by Miss Des Claves.

Doctor Shepherd was fond of literature and art and was a recognized critic of oil paintings. He was twice president of the Montreal Art Association. For many years he was a member of the Board of Trustees of the National Gallery at Ottawa and Chairman of the Board at the time of his death.

Doctor Shepherd had two daughters, and one son who was a war casualty.

Among McGill's distinguished graduates, Doctor Shepherd's name stands high. His influence in the profession and socially was very great. He always stood for what was pure and noble, and he set his face definitely against all commercializing tendencies and always had the full confidence of his confreres and especially of the younger men who looked up to him for guidance.

GEORGE E. ARMSTRONG

#### EDITORIAL ADDRESS

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## OBSERVATIONS ON BLOOD GROUPING AND BLOOD TRANSFUSION \*

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DUE to the increasing importance of blood transfusion as a therapeutic measure, blood grouping has become one of the commonest and one of the most important laboratory procedures. During the last few years, many articles have appeared describing the occurrence of irregular iso-agglutination reactions. Landsteiner and Witt<sup>1</sup> maintain that many of these irregular reactions are due to technical errors, some to pseudo-agglutination, others to cold agglutinins and, in rare instances, to anomalous iso-agglutinins as in the case cited by Ottenberg and Johnson.<sup>2</sup> Landsteiner and Levine<sup>3</sup> showed that the irregular agglutinins which they found were not sufficient to cause a post-transfusion reaction in five patients. However, Guthrie and his co-workers<sup>4</sup> consider the irregular iso-agglutinins which they found as equivalent to the ordinarily accepted ones. They believe that these iso-agglutinins are missed by the ordinary routine tests for blood grouping and that many of the post-transfusion reactions are due to the incompatibility of the bloods with respect to these newly described iso-agglutinins.

At a hospital where the services are as active as those at Bellevue, many blood transfusions are performed. As most of the patients are financially unable to afford a professional donor, members of the family and their friends are called to act as donors. This necessitates a great number of blood grouping examinations. Thus we are in a position to make many interesting observations which may throw some light upon the importance of these irregular reactions.

Ten thousand bloods were examined for groupings during the period beginning December, 1925, and ending July 1, 1929. The bloods were classified according to the Jansky<sup>5</sup> nomenclature. In this paper we shall use the nomenclature recommended by Landsteiner<sup>6</sup> and accepted by the Hygiene Committee of the League of Nations.

We use the open macroscopic method of Vincent<sup>7</sup> for determining the group to which an individual blood belongs. This, Ottenberg<sup>8</sup> claims, is the method of choice for a routine laboratory. We use defibrinated instead of citrated blood, since Grove<sup>9</sup> showed that sodium citrate exerts a distinct inhibiting action upon the agglutination of certain Group B cells. The sera used for testing are collected from the bloods that have already been exam-

\* Read before the New York Pathological Society, November 21, 1929.

ined in the laboratory. The bloods are centrifuged and only the clear yellow sera are kept. All Type A sera are pooled as are also Type B. The composite sera are tested against known red cells. By this method we are assured that our testing sera have a fairly high titre of iso-agglutinins, and are not anomalous. If an anomalous sample of serum is overlooked, it is diluted by being mixed with normal sera of the same type. The sera are kept in properly labeled dropping bottles in the ice-box at 0° C. When they are to be used they are taken out and kept at room temperature for a short time. Sera collected and kept in the manner indicated remain active for a fairly long time.

### I. *Frequency of blood groups.*

The relative frequency of the four groups in our series compares very closely to that reported by other American investigators as can readily be seen in Table I.

TABLE I

Investigator	Year	No. of Bloods	O	A	B	AB
Hektoen <sup>10</sup> .....	1907	75	46.4	43.4	7.2	3.0
Moss <sup>11</sup> .....	1910	1,600	43.0	40.0	7.0	10.0
Karsner <sup>12</sup> .....	1918	1,000	46.2	42.4	8.3	3.1
Culpepper <sup>13</sup> .....	1921	5,000	44.5	36.0	14.3	5.2
Buchanan and Higley <sup>14</sup> .....	1921	1,536	46.9	40.8	8.5	3.6
Ottenberg <sup>15</sup> .....	1921	286	44.0	42.0	12.0	2.0
Snyder <sup>16</sup> .....	1929	20,000	45.0	41.0	10.0	4.0
Tiber.....	1929	10,000	45.6	36.4	13.5	4.5

When compared with the results of European investigators, we find that our figures agree fairly well with those given for the Southern European races. Hirschfeld and Hirschfeld,<sup>17</sup> in an interesting article pertaining to the distribution of blood groups among the various races, show that Group A is more prevalent among the Europeans and Group B among the Asia-African races. The countries lying between Asia and Central Europe show an intermediate distribution. Table II shows the English heading the list with 43.4 per cent. Group A and 7.2 per cent. Group B. Passing to the people east and south of England, Group A decreases and Group B increases, until we get to India where Group A is but 19 per cent., and Group B 41.2 per cent. Since most of the patients treated at Bellevue Hospital are descendants of Southern Europeans we can readily explain our findings.

### II. *Results of testing red cells with known type A and B sera.*

In our series there were only fifteen bloods in which the agglutination of the red cells was questionable with our testing sera. That is, the reaction was not as strong as is usually seen and the individual performing the test felt that a check was indicated. In these cases he requested that a cross-

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TABLE II

	O	A	B	AB
<i>European</i>				
English.....	46.4	43.4	7.2	3.0
Italian.....	47.2	38.0	11.0	3.8
German.....	40.0	43.0	12.0	5.0
Austrian.....	42.0	40.0	10.0	8.0
Greek.....	38.2	41.6	16.2	4.0
<i>Intermediate</i>				
Arab.....	43.6	32.4	19.0	5.0
Turk.....	36.8	38.0	18.6	6.6
Russian.....	40.7	31.2	21.8	6.3
Jew.....	38.8	33.0	23.2	5.0
<i>Asia-African</i>				
Negro.....	43.2	22.6	29.2	5.0
Indian (Hindu).....	31.3	19.0	41.2	8.5

agglutination be done before the transfusion. It is well known that in anæmic bloods the macroscopic method may be difficult to read. Clotted bloods should not be typed by this method for they too may give questionable results. It is possible that some of these fifteen bloods were from anæmic persons and that others were clotted, but the operator took it upon himself to do the tests in spite of this. Quite likely the more accurate test tube method would have precluded this difficulty.

We may conclude that the grouping of the red cells was performed without difficulty in all but fifteen cases. These cases were questionable because the macroscopic method was used on bloods that were probably anæmic or clotted.

## III. Results of testing sera with known red cells.

In some cases the serum as well as the red cells were tested. The exact number in which this was done is not known, as no record was made where the serum and cells gave the required tests. In only six cases recorded in Table III, the serum was found to give reactions which were different

TABLE III

Name	Group to Which Cells Belong	Action of Sera of Same Patients
C.....	O	Agglutinates B but not A cells
F. McV.....	O	Agglutinates B but not A cells
R.....	A	Does not agglutinate A or B cells
D.....	A	Does not agglutinate A or B cells
J. F.....	AB	Agglutinates B cells
J. H.....	A	Does not agglutinate A or B cells

from those usually given by the serum corresponding to the group to which the cells belong; *e.g.*, the cells of patient C were not agglutinated by the known type A and B sera, but her serum agglutinated the cells of a sample of blood belonging to Group B, but not one of Group A.

Before reporting the finding of atypical sera, it is necessary to make exhaustive tests with many different samples of red cells of the same and different groups under varying conditions and to make thorough quantitative studies of each of the sera in question.<sup>1, 18, 19</sup> Since our sera were tested by the macroscopic method alone with only one, or probably two, specimens of red cells, and as no quantitative studies were made, we are unable to make any definite statement about these sera other than to say that they were encountered. It is possible that these sera were not atypical. It is a well-

TABLE IV

Name	Group	Remarks
Mrs. E.....	O	} .....Serum agglutinates cells of Mrs. E.
Mr. E.....	O	
Wm. McE.....	A	} .....Serum agglutinates cells of Wm. McE.
J. F.....	A	
M. McL.....	O	} .....Serum agglutinates cells of M. McL.
H. M.....	O	
J. D., Sr.....	O	} .....Serum agglutinates cells of J. D., Sr.
J. D., Jr.....	O	
R. O'C.....	O	} .....Serum agglutinates cells of R. O'C.
M. O'C.....	O	

known fact that many red cells are weakly agglutinated and that sera vary in their agglutinin titre. Since our tests were made by the macroscopic method, it is possible that the agglutination was so weak that it could not be seen by the naked eye.

In view of the fact that six so-called atypical bloods were encountered by testing the sera of only a comparatively small number of our cases, we may assume that many similar sera passed unnoticed.

#### IV. *Irregularities discovered by cross-agglutination.*

Of the small number of bloods which were cross-matched, in only five cases was it found that although the donor and recipient belonged to the same group, the cells of one were agglutinated by serum of the other.

In this series the donors were discarded and new donors obtained. It is unfortunate that these bloods were not studied more thoroughly. How many similar bloods passed unnoticed, we are unable to say, but we have reason to believe that many were used in our series of transfusions.

V. *Study of blood transfusion records.*

A study of the blood transfusion records at this hospital was undertaken in order to determine what effect irregular bloods, similar to those described above, had on the outcome of the transfusion. During the three and one-half-year period ending July 1, 1929, 1,467 blood transfusions were performed. The majority of these were done by the Lindeman<sup>20</sup> syringe method and a few, on infants, by the indirect citrate method. There were but 2 deaths in this series: A woman twenty-four years old, and a child of two months.

CASE I.—M. G., female, married, twenty-four years of age, United States housewife. Admitted because of vaginal bleeding and abdominal pain. Diagnosis of post-abortion salpingitis, secondary anæmia. A blood transfusion was deemed advisable because of the severity of the anæmia. Patient typed in the routine manner and was classified as a Group O. Her husband, who was used as donor, had been reported as belonging to Group O also. The transfusion was given and before 400 cubic centimetres were injected, the patient developed cyanosis, dyspnœa, cough and a severe headache. The transfusion was concluded and the patient returned to the ward immediately. The patient died fourteen days later from anuria.

Due to the reaction of the patient during the transfusion, the husband's blood was retyped and found to belong to Group A and not Group O, as previously reported.

CASE II.—H. M., male, age, two months. Admitted because of malnutrition, dehydration, secondary anæmia; making an emergency blood transfusion necessary. The child's blood was typed and found to belong to Group A. The mother's blood belonged to Group O. Inasmuch as the mother could not afford a professional donor, it was decided to chance her as the donor because of the critical condition of the child. The child died about two and one-half hours after the transfusion with all the signs and symptoms of a typical transfusion death.

Autopsies were performed on both these patients and the findings will be reported at a later date.

These two deaths are readily explained: The first resulted from the use of an incompatible blood, due to a technical or clerical error, and the second was caused by incompatibility of the bloods due to the use of a so-called universal donor in an anæmic child.<sup>21</sup>

From these facts we may conclude that the differences noted in the serum of some individuals within the same group, as determined by typing the red cells, are of a minor character and are not sufficient to cause death even if such an individual is used as a donor or recipient. Landsteiner and Levine<sup>3</sup> observed "uneventful transfusions in five patients whose sera agglutinated distinctly the cells of the respective donors, some of the sera acting even at 37° C."

In order to emphasize this point, we searched the literature for statistics on blood transfusions.

Bernheim<sup>22</sup> in 1917, collected reports of 800 blood transfusions from twelve surgeons and found a total of ten deaths; no tests for compatibility had been performed in three cases, one was typed wrongly, four died of cardiac failure and two from anaphylactic shock. Pemberton<sup>23</sup> in 1919,



reported three deaths in 1,036 blood transfusions at the Mayo clinic; all resulting from the use of incompatible bloods due to technical or clerical error in the laboratory. Copher<sup>24</sup> in 1923, reported two fatalities in 245 transfusions; in one case the patient matched perfectly with the donor, but died eleven days later. The second death resulted from the use of an incompatible donor following an error in the laboratory. Kordenat and Smithies<sup>25</sup> in 1925, reported no deaths in 764 transfusions. Brines<sup>26</sup> in 1928, reported no deaths in 2,500 transfusions. The Blood Transfusion Service of the British Red Cross Society<sup>27</sup> reported five deaths in 3,430 blood transfusions; three were due to wrong types, one occurred in a man with

TABLE V

Investigator	Year	Tests	No. of Transfusions	No. of Deaths	Cause of Death			
					Wrong Type	Primary Dis.	Heart Failure	Unknown
Bernheim <sup>22</sup> ...	1917	Grouping	800	10	4	0	4	2
Pemberton <sup>23</sup> ...	1919	Grouping	1,036	3	3	0	0	0
Copher <sup>24</sup> .....	1923	Grouping, x-matching	245	2	1	0	0	1
Kordenat and Smithies <sup>25</sup> ...	1925	Grouping..	764	0	0	0	0	0
Brines <sup>26</sup> .....	1928	Grouping..	2,500	0	0	0	0	0
Brit. Red Cross Soc. <sup>27</sup> .	1929	Grouping..	3,430	5	3	1	0	1
Tiber.....	1929	Grouping..	1,467	2	2	0	0	0
Totals.....			10,242	22	13	1	4	4

advanced malignant disease who died during an attack of syncope while being transfused, and the fifth in a woman whose blood was compatible with the donor but she died eleven days later of anuria.

Table V shows that in a total of 10,242 blood transfusions there were but twenty-two deaths: incompatibility of the bloods being the cause of thirteen deaths, heart failure four, the primary disease one and unknown cause four. Whether a mistake was made in grouping the bloods of the last four cases one cannot decide, because these bloods were not sufficiently studied.

In Pemberton's<sup>23</sup> series there were twelve instances in which there were group reactions due to errors in the testing of the bloods. In three of these the symptoms were not recognized during the transfusion, the patients receiving the full 500 cubic centimetres with resulting death. In the nine others, the symptoms were recognized and the transfusion stopped after the injection of 50 to 100 cubic centimetres with no mortality. Thus if a patient receives 500 cubic centimetres of incompatible blood, death follows, whereas

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the injection of only a small amount results in a severe reaction from which the patient usually recovers.

Guthrie and his co-workers<sup>4</sup> claim that the irregularities in blood grouping are due to heretofore unrecognized iso-agglutinins of the same order as those usually accepted. If this is so we should expect a higher mortality than we actually obtained in our series and those collected from the literature. In view of the fact that the total mortality is but 0.39 per 1000 blood transfusions, with the present methods of blood grouping, we may conclude that these methods are efficient for the purpose of determining the compatibility of donors and recipients.

### SUMMARY

Ten thousand bloods were examined for grouping by the Open Macroscopic method of Vincent. Forty-five and six-tenths per cent. fell into Group O, 36.4 per cent. Group A, 13.5 per cent. Group B and 4.5 per cent. Group AB. The material used for testing these bloods consisted of pooled specimens of Group A and B sera. The grouping of the red cells was without fault in 9,985 bloods. Fifteen gave questionable agglutination because they were either clotted or very anæmic. The sera of a small number were tested with known red cells and it was found that in six cases the typing did not check with the results obtained by typing the red cells. (See Table III.) In five cases, in which the donor and the recipient were of the same group, there was agglutination when the bloods were cross-matched. In 1,467 blood transfusions there were but two deaths: One as a result of an error in technic and the second as a result of the use of a so-called universal donor. Ten thousand two hundred and forty-two blood transfusions were collected from the literature with twenty-two deaths from all causes in this series. Thirteen were due to wrong types, one to primary disease, four to heart failure and four to unknown cause.

### CONCLUSIONS

1. The Open Macroscopic method of Vincent is efficient for determining the blood group of recipients and donors.
2. Testing sera should consist of pooled specimens of Group A and B sera.
3. Grouping by this method should be determined by testing the red cells alone.
4. The classification of bloods into four groups is sufficient for the purpose of blood transfusion.
5. The death rate for blood transfusions is 0.39 per thousand.

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# RELATION OF PROTEIN DIET TO THROMBOSIS

THE IMPORTANCE OF BLOOD COAGULABILITY AND DIETARY  
TREATMENT IN THROMBOSIS AND HÆMORRHAGIC CONDITIONS

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AT VARIOUS times since 1921, we have presented evidence of the relation of food intake to blood coagulability, pointing out the increased coagulability following protein intake and the lack of such effects with carbohydrate or fat.<sup>1</sup> For the last four years the writer has made use of this knowledge in the treatment of different forms of hæmorrhagic diseases, good results following the use of frequent protein feedings throughout the day. Many cases of frequent and repeated bleedings show a great disposition for such bleeding to take place four hours or more after the last preceding meal, when the protein effect has worn off.

A closer analysis of this protein effect in 1928<sup>2</sup> led us to the conclusion that it was intimately related to a more rapid platelet clumping and lysis which takes place at such a time, and that rather strenuous exercise or adrenalin injection may produce similar effects on the blood coagulability and platelets. Since the onset of thrombosis is usually based on a platelet clumping and disintegration in the stagnant venous blood, and since so frequently one sees it appear at about the same time that the patient is put on a full diet and allowed out of bed, we suggested in 1927<sup>3</sup> that damage might result from the protein in the diet for the first two weeks after operation, termination of pregnancy, or acute febrile disease.

Recently Barcroft, Kugelmass and Stanley-Brown<sup>4</sup> have presented the results of studies on blood coagulability in thrombosis, embolism, and hæmorrhagic states, based mainly on our past work. They show the beneficial effects of such dietary procedures as have just been mentioned. Their results are definite and conclusive as to the influence of diet on coagulability, showing that one can change this property of the blood almost at will. The diets listed in detail by them should prove very useful, although in hospitals having a dietitian great variability is allowable so long as proper attention is paid to the protein content.

When it comes to an application of their methods of studying patients to determine which should receive dietary treatment, it will be found that very few hospitals will be able accurately to carry out the tests on the blood because of technical difficulties. It becomes necessary, therefore, to lay down certain principles for the general handling of such classes of cases as are known to be prone to embolism or thrombosis. These classes include cases undergoing (a) trauma with considerable tissue mutilation; (b) surgical

operations, especially intra-abdominal; (c) parturition; (d) acute febrile diseases, especially pneumonia and typhoid fever; (e) cardiac decompensation; and (f) phlebitis. Before attempting to specify a general line of prophylaxis against thrombosis in these conditions, one further point should be stressed.

In post-operative, post-partum, and post-febrile states, it has been found by a number of investigators that the platelet count, which suffers a rather severe depression during fevers and parturition, begins to rise soon afterwards, reaching a peak on the eighth to eleventh day after the fever subsides, or after childbirth or operation. This peak usually shows a platelet count of almost twice the normal. A subsidence back to normal takes place in the subsequent four to five days. Reimann<sup>6</sup> observing the platelets in pneumococcus infections, found that they fall 40-50 per cent. during the febrile period, but begin to rise again as the fever falls, to reach a maximum on the twelfth to fourteenth day approximately double the normal number. Port and Akiyama<sup>7</sup> had noted a similar behavior of the platelets in pneumonia, erysipelas and scarlet fever, while Helber<sup>8</sup> observed the marked rise in the week succeeding the pneumonia crises and by the eighth day of normal temperature following typhoid fever. Lee, Minot and Vincent<sup>9</sup> found after splenectomy that the platelets were very large in size and doubled or tripled in number, and that thrombosis was a frequent sequel of this operation. Hueck<sup>10</sup> describes a decrease in number of platelets for the first five days after various operations, with a rise much above normal on the eighth to the eleventh day. Others who have observed the rise following acute infections are Gram<sup>11</sup> and Beck.<sup>12</sup>

This platelet rise thus takes place just at the time most patients of the above classes are being allowed up for mild exercise and at the time when full diet is permitted (and often encouraged to quicken recuperation). Thus we have a period when all factors favoring thrombosis are at a maximum: the platelets are greatly increased; increased protein intake increases their tendency to clump and disintegrate; and this is further aided by the exertion of moving around; and finally the action of the sluggish circulation is intensified during the first few days of sitting up or getting out of bed. Aschoff<sup>5</sup> in his lecture on thrombosis admirably discussed these various factors which tend to favor thrombosis.

To illustrate the importance of these factors, a few case histories are briefly abstracted below.

CASE I.—Woman, age thirty-eight years, was operated for uterine fibroids July 11. On the 23rd, *twelve days after the hysterectomy*, she developed left femoral thrombosis. No note as to diet.

CASE II.—Woman, twenty-seven years old, had an appendectomy on June 23 for acute appendicitis. Ten days later, July 3, she was changed from a liquid diet to full diet. The next day, July 4, she developed right femoral thrombosis.

CASE III.—Woman, thirty-five years old, underwent operation for uterine suspension and removal of the appendix on September 5. She was changed from liquid to soft diet on the 9th, and died suddenly from embolism on the 12th.

Barcroft, Kugelmass and Stanley-Brown, in the article referred to above, cite four of their cases in which thrombosis or embolism occurred, one on the sixth, one on the ninth, and two on the eleventh day post-operative. The embolism on the sixth day immediately followed the exertion of the patient arising from his bed to walk to the toilet. Most surgeons of long experience will agree that this period from ten to fourteen days after operation is most fraught with the dangers of thrombosis and embolism. It so often occurs just as the patient is ready to leave the hospital, or within a day or two after his return home.

On the basis of the facts and observation cited above, it would seem very advisable to keep all patients on a very low protein diet for the first two weeks following (a) operations, especially splenectomy or other operations within the abdomen or pelvis; (b) trauma, with much tissue mutilation; (c) childbirth; (d) acute febrile diseases, such as pneumonia, typhoid, etc.; (e) cardiac decompensation at all times, but especially with auricular fibrillation; (f) phlebitis at all times.

A high protein diet, with feedings every three to four hours, should be used in cases exhibiting a *hæmorrhagic tendency*.

Following childbirth it is recognized that such restriction of diet may not always be advisable on account of its effect on milk production, but this can largely be alleviated by a generous supply of carbohydrates and fats.

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## EXPERIENCES WITH SODIUM AMYTAL AS A GENERAL ANÆSTHETIC \*

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THE resistance by patients to the advice of surgeons that an operation is desirable or essential to health or life is an everyday feature of professional experience. The resistance is stressed in terms not of fear of the cutting, but of fear of losing consciousness through the medium of an inhalation anæsthesia. This is a fear engendered by conversation with those who have been operated upon. Friends and relatives rehearse the unpleasant phenomena which they suffered incident to breathing gas and ether. They tell of the smothering and strangling sensation and of the struggling and fighting against the fear of impending death. Prospective operatives often conclude that living with a disability is preferable to the subjugation of one's self to the mental agony which, while anæsthesia is being produced with noxious vapors, is said to be an eternity in passing.

The observation of Doctor Killian of Germany that "Consideration of the psychic condition of the patient is identical with the protection of the whole organism" is profound clinical truth. "Many patients squander their physical and psychic energies through anxiety over the operation"—which includes fear of the anæsthetic—"and not from the serious strain which the operation itself represents." Doctor Crile recognized the deep importance of these observations in his work on goitre. He stole his toxic thyroid patients to sleep.

Having direct bearing on the protection of the psychic, when surgical procedures are necessary, has been the introduction into the field of anæsthesia of Sodium Amytal. Sodium Amytal has evolved out of the study of barbituric acid derivatives since veronal was found a valuable hypnotic in 1903. Physiological chemists, pharmacologists and clinicians have experimented extensively since that time and have given to the profession allonal, medinol, luminal, amytal and other closely related drugs used mainly by internists. The possibilities in the surgical field have not been overlooked and the above drugs have been used with indifferent successes as anæsthetics.

The distinction of finding a barbituric acid derivative of signal worth in the induction of anæsthesia belongs to the Eli Lilly laboratories. For five years their chemists experimented with, perfected and used Sodium Amytal on animals. Doctor L. G. Zervas and his associates in the Indianapolis City Hospital had the courage to try the drug on humans. Early this year Doctor Zervas reported his achievement and successes on three hundred surgical cases. It is not hard to believe that in the future Doctor Zervas will be

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\* Read before the Western Surgical Association, December 12, 1929.

justly honored as the individual who has made the outstanding contribution of modern times to the betterment and safety of anæsthesia.

The boon to the patient, lessening or abolishing the fear of inhalation anæsthesia, is the taking of Sodium Amytal in bed in his own room. The drug is given intravenously. Sleep comes quickly, like unto a child. When asleep the patient is moved to the surgery, operated upon and returned to his bed to sleep peacefully for hours without many of the distressing post-operative phenomena.

Our interest in Sodium Amytal was aroused early this summer at the Mayo clinic where it had been employed in over one thousand cases with happy results. Doctor W. J. Mayo spoke highly of its virtues. "Since the middle of August, I and my surgical associates of the Santa Barbara Clinic, Doctors Wills, Eder and Atsatt, have operated upon eighty-two cases with Sodium Amytal as an induction anæsthetic. I shall not enumerate the cases. The series include: leg and thigh amputations, arthrotomies, breast amputations, gastro-enterostomies, colostomies, acute and subacute appendectomies, hæmorrhoidectomies, cholecystectomies, nephrectomies, prostatectomies, salpingectomies, perineorrhaphies, hysterectomies and hernioplasties."

Sodium Amytal is sodium iso-amyl ethyl barbiturate and is furnished by the manufacturing pharmaceutical house of Eli Lilly Company as a dry powder in ampules. With each ampule is a companion ampule of 10 cubic centimetres of sterile distilled water. With a sterile syringe the water is introduced into the ampule of powder. Several minutes are required for complete solution and escape of air bubbles. The solution must be absolutely clear and must be injected not later than fifteen minutes after its preparation. Only those trained in the methods and principles of anæsthesia should give the drug for the production of surgical anæsthesia. In our series of cases much credit for our results has been due to Doctor F. L. Grandstaff, who was recently associated with Doctor Zerfas in his work at the Indiana University Hospitals.

Our procedures in the induction of anæsthesia are: The patient is given by mouth chloretone grs. 10 the night before and early in the morning of the operation as recommended by Doctor Lundy of the Mayo Clinic. One-half hour before operation morphine gr. 1/6 and atropine gr. 1/120 are given by hypodermic. Just before the operation Sodium Amytal is introduced intravenously at the rate of 0.75 to 1.0 cubic centimetres per minute. The amount of the drug to be given is determined by the weight of the person, by the age and by the metabolic rate. We have used from 7½ to 21 grains. A rough estimate is 1 grain to ten pounds of body weight. We have averaged 11 to 13 grains. Febrile patients and alcoholics took the maximum dose. Obese individuals seemed to require less of the drug per body weight than did the spare.

During the injection of the Sodium Amytal, blood-pressure readings were made frequently by an assistant. In our series the fall of pressure was



found to be more marked than found by Doctor Zerkas and his associates. The fall seems to depend upon the patient's normal blood pressure. In cases with systolic pressure of from 130 to 170 millimetres the fall varied from 40 to 70 millimetres, whereas, in cases with pressures of from 90 to 130 millimetres, the fall ranged from 10 to 30 millimetres. In one case there was a fall from 170 millimetres to 50 millimetres, 120 points. It was also observed that hypnosis was more rapid with increased fall of blood pressure. In our series blood pressure returned to normal in from fifteen to thirty-five minutes.

Patients were soundly asleep in from three to five minutes. The passing from consciousness to sleep was like that of normal falling to sleep—calm, peace and oblivion. Many definitely snored. There was no excitement and no laryngospasm. In about fifteen minutes, the time occupied in giving the drug, there was general body relaxation with almost complete abolishment of the common reflexes with the exception of the pharyngeal. The respiration rate varied—slight increase or decrease—but always there was a decreased amplitude of movements of the chest. The action of the pulse was affected but little.

In the operating room before the incision was made, nitrous oxide gas was administered to the sleeping patient. Ether and ethylene were not used in our series. Although complete surgical anaesthesia can be produced by Sodium Amytal in large doses, it is probably not safe to use it. With the moderate doses we used we early learned that the patient moved his limbs or body when the incision was made and if gas was not given, movements continued when operative procedures were under way.

Sodium Amytal is perhaps technically not an anaesthetic. It does, however, produce sleep either with or without analgesia and anaesthesia. When the drug is used within its safety limits, the amount of supplementary gas needed was but from 60 to 85 per cent. of that usually inhaled.

The post-anaesthetic phenomena were pleasing to patients and to us. Patients slept more or less steadily for a period of from twelve to twenty-four hours. They were usually sufficiently conscious in four or five hours to drink water and often to void. At the end of twenty-four hours they were wide awake as from normal sleep with little or no memory of the events from the time of taking the Sodium Amytal until the complete awakening. During this period the absence of nausea, retching and vomiting was gratifying as was also the freedom from complaint of pain. The administration of fluids intravenously and subcutaneously was more easily done during this semi-conscious interval.

Post-operative gas pains were markedly lessened in the succeeding days. The bowels moved earlier, sometimes without aid. The non-striated musculature of the intestines was probably not paralyzed by the Sodium Amytal. There was no delirium in our cases. There was some increased restlessness which was controlled by small doses of morphine.

When patients were later able to talk about their operations they were

enthusiastic in their praises of Sodium Amytal. Those who had been operated upon under gas and ether and again under Sodium Amytal contrasted their experiences to the detriment of the former and highly in favor of the latter. Two physicians who had seen the drug given insisted upon its use on themselves when they had to be operated upon.

In this picture of a new anæsthetic are there any disturbing shadows? There are a few. Except for one they are relatively of little importance. About 25 per cent. of our patients required catheterization. We tried to avoid this procedure by giving benzyl-benzoate. Two of our series had inability to raise mucus and one of them died from hypostatic œdema of the lungs—a man of seventy-seven upon whom a prostatectomy had been done. Lung œdema can be controlled by inhalation of carbon dioxide and oxygen as suggested by the Mayo Clinic. Sodium Amytal patients require special nursing from twenty-four to forty-eight hours. This is essential that possible delirium and restlessness may be controlled and to bring forward the tongue if it should fall back due to the relaxation of the throat which is said to happen occasionally. Special nursing adds to expense. Two patients had a rash which disappeared in twenty-four hours.

The one shadow which causes real concern is the occasional pronounced fall in blood pressure. Whether or not the fall is detrimental to a patient's welfare, immediate or remote, has not to my knowledge been determined. The rapid introduction of or the giving of too much Sodium Amytal is, of course, subject to control.

# AN ANALYSIS OF ONE HUNDRED AND FORTY-EIGHT OPERATIONS FOR GOITER\*

BY CHAS. GORDON HEYD, M.D.

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THIS paper presents an analysis of 148 operations performed for goiter upon 144 patients between January 1, 1927, and June 30, 1929. While the number is relatively small, it is sufficiently large to be fairly representative of the results to be expected together with the technical difficulties and complications which may be encountered in thyroid surgery.

During the same period of time in the Goiter Clinic at the New York Post-Graduate Medical School and Hospital we have examined 809 new cases and 1754 return cases—a total of 2563 cases of goiter. In the series presented herewith there were dispensary and private patients. After the clinic was started it became necessary to have a clinical classification of goiters in order that the cases might be properly classified and certain broad lines of therapy established. We decided upon a classification which was largely based upon thyroid function and have divided all goiters into three groups: (a) goiters with hyperthyroidism: (b) goiters with hypothyroidism, or approximately normal secretion, and (c) neoplastic goiters. Subdivisions of these three main categories give us a classification table as follows:

## CLINICAL CLASSIFICATION OF GOITER

### A. Goiters with hyperthyroidism—hypersecretion or dysfunction.

#### 1. Goiter of adolescence.

Physiological gland with overfunction.

#### 2. Goiter of Graves' disease.

Pathological gland with overfunction and dysfunction.

#### 3. Goiter of adenoma—adenomatosis.

Pathological gland with overfunction.

### B. Goiters with hypothyroidism or normal thyroxin secretion:

#### 1. Simple, endemic goiter and colloid goiter.

Pathological gland—secretory activity normal or diminished.

#### 2. Goiter of adenoma.

Pathological gland—secretory activity normal or diminished.

### C. Neoplastic goiters and inflammatory goiters.

This classification is purely clinical and does not attempt to differentiate goiters upon a pathological basis although there is a definite parallelism between the various clinical subdivisions and the various types of pathological histology of the thyroid gland.

In so far as diagnosis and treatment are concerned it is immaterial whether one accepts the idea recently advanced that all goiters are varying phases of

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one continuous process or whether one adopts the more prevalent opinion that there are distinct subdivisions in the pathological classification of goiter.

In the last few years we have had three different pathologists, all expert, give their opinion upon our goiter material. When their reports are frankly analyzed it is found that there is a greater divergence of unanimity in pathological nomenclature than there is in a "workable" clinical classification. The introduction of iodine, both prophylactically and therapeutically, the extreme publicity given to it, its widespread indiscriminate use by the profession and in a wholesale manner by the laity, has tended to confuse the pathological picture with the clinical symptoms in many cases.

The classification of our 148 operations was as follows:

Hyperthyroidism .....	95 cases.
Hyperthyroidism of adolescence .....	3
Hyperthyroidism of Graves' disease * .....	56
Hyperthyroidism of adenoma .....	36
Hypothyroidism or normal secretion .....	45 cases.
Colloid goiters .....	24
Adenoma .....	21
Neoplastic, or inflammatory .....	8 cases.
Malignant goiters .....	5
Riedel's struma † .....	2
Tuberculosis .....	1

There is a very marked clinical difference in the typical case of hyperthyroidism of Graves' disease and the typical case of hyperthyroidism of adenoma. The hyperthyroidism of Graves' disease is an acute, overwhelming intoxication, apparently due more to a dysfunction of thyroid secretion than to a pure hypersecretion. It would seem to be primarily not a disease of the thyroid gland, but a loss of the normal control of thyroid secretion. The gland in Graves' disease per unit weight contains less iodine than the normal thyroid, yet the blood serum shows an excess of iodine. It may be deduced that there is a widespread change in the normal threshold of thyroid secretion and that as rapidly as thyroxin is elaborated by the gland in Graves' disease it is passed out into the circulation as an ill-formed, unstable thyroxin molecule. The result is a thyroid intoxication that is markedly different from that which occurs in adenoma. In Graves' disease the onset is rapid, ascribed to some great or passing psychic event, and from the time the symptoms begin until there is a fully developed picture of the disease the interval is usually less than a year. It occurs in relatively young people, with a large majority of the cases between the twentieth and thirtieth year. Exophthalmos is an outstanding feature, being present in 50 per cent. of the cases within the first year and in 80 per cent. of the cases within the two years. In our experience if the patient has received no iodine previous to operation it is the safest type of hyperthyroidism for surgery when controlled pre-operatively and post-operatively by iodine medication. By reason of the

\* Three patients with Graves' disease had a second operation.

† One patient with Riedel's struma had a second operation.

fact that it occurs in young subjects there is seldom any of the marked cardiac disability which is observed in the hyperthyroidism of adenoma. While the heart action in Graves' disease is markedly exaggerated and tachycardia is the most prominent symptom, yet the heart is ordinarily basically sound and is only "speeded up" and overworked. The completeness of recovery from Graves' disease after operation is dependent upon the length of time with which the patient has suffered from the hyperthyroidism. If the hyperthyroidism has been long continued there are very definite and permanent degenerative changes in the heart, brain, kidneys and liver, and while in the majority of cases symptomatic cure is complete there are some patients who suffer throughout the remainder of their lives with a tendency to tachycardia and an exaggerated reaction to any irritating or emotional stimuli.

We have a small group of goiter cases which have had a typical Graves' disease symptomatology, with basal metabolism  $+70$ , and who after operation acquire a normal basal metabolism,  $+11$ . There is no evidence of regrowth of thyroid; the only remaining symptom is a persistent tachycardia. This type of patient requires a prolonged convalescence before the tachycardia disappears, if it ever does. These patients are extremely prone to have a tachycardia on the slightest disturbing influence of environment, or finances, or of emotion. We have found that the post-operative administration of Lugol's solution, or sodium iodid, in small doses, five minims twice a day for two or three months, following operation, brings about a more rapid gain in weight, a marked slowing of the pulse and a more complete general physical improvement.

The convalescence after operation for Graves' disease is a much more delicately balanced affair than after adenoma and requires a much greater degree of post-operative supervision.

In the 36 patients exhibiting hyperthyroidism of adenoma 60 per cent. came to the clinic for cardio-vascular disability rather than for the more obvious goiter. The age incidence varied from thirty-five to sixty years and the characteristic history was that the patient had had a goiter of many years' duration, and aside from the cosmetic effect it had been a matter of no concern to the patient. Loss of weight was not a great factor in the majority of these patients. Their basal metabolism average was  $+42$ , and as a group the basal metabolism never reached the elevation present in the hyperthyroidism of Graves' disease. Sixty per cent. of the adenoma group presented definite evidence of organic heart disease, aside from palpitation and tachycardia. It is significant that at the present time this group represents a greater operative risk than Graves' disease. In the series there were three deaths, one following an operation for Graves' disease and two following operation for hyperthyroidism of adenoma. In our opinion, the hyperthyroidism of adenoma is the least influenced by pre-operative medication with iodine. Auricular fibrillation and occasionally, auricular flutter were the chief types of cardiac disability.

It is interesting, however, to note that the recovery, both operatively and

post-operatively, was more rapid in this group than in Graves' disease and physical and functional competency of the thyroid gland was accomplished by relatively less surgery than in Graves' disease. The cardiac disability was invariably lessened and in many cases functionally cured. It is a noteworthy fact that all five cases of malignancy in this series had their origin in the adenoma group. Three cases were classified as precocious adolescent hyperthyroidism. The youngest patient was thirteen years of age, with a basal metabolism of  $+77$ , and the eldest patient sixteen years of age, with a basal metabolism of  $+68$ . All three had received rather large quantities of iodine over a long time with no permanent or continuous benefit, but on the contrary after a slight temporary betterment had an increase in their toxicity.

Two of my associates, Doctor Moolten and Doctor Fleming, have independently observed that there are some supposedly colloid goiters in young adults, with normal basal metabolism, which under the administration of Lugol's solution diminish in size, but coincidentally the patient develops a tachycardia and an elevated basal metabolism. We have come to the conclusion that in these patients, while the thyroid gland in general was "toned up" and improved under iodine, there were present in the gland small undetected adenomata which were stimulated and induced some degree of subsequent hyperthyroidism.

Twenty-four patients with colloid goiter were operated upon for pressure symptoms or cosmetic reasons.

We have taken the surgical position that all isolated or discrete tumors, whether single or multiple, occurring in the thyroid gland should be removed. There are four well-defined reasons for this attitude: (1) normal retrogression and disappearance does not take place: (2) there is the tendency to progressive growth: (3) the known tendency for the development of hyperthyroidism, and (4) the actual and potential danger of malignancy.

We have observed a number of cases of typical Graves' disease without any visible or palpable enlargement of the thyroid gland and having a moderate degree of hyperthyroidism. Basal metabolic rates range in the  $+30$  and  $+40$  group. In these cases we have had recourse to X-ray therapy under the direction of Dr. Wm. H. Meyer, and the results have been, on the whole, satisfactory. We have been influenced largely in treating these cases with X-ray upon the following premises: that the size of the thyroid gland renders it extremely difficult to determine how much should be removed by surgical intervention and the greater liability of parathyroid and nerve injuries. On the other hand, the Graves' disease with a definite goiter and a more severe degree of hyperthyroidism is, in our opinion, best treated by surgery as the danger of full, intensive X-ray is greater than the mortality risk in surgery. The final results of full, intensive X-ray therapy is a devitalized, atrophied telangiectatic area that cosmetically is worse in its final appearance than any thyroid incision, and functionally, the final result is more apt to be myxedema than where surgery is employed.

In regard to basal metabolism, it is essential that the metabolic determinations be made at all times by the same laboratory. After a reasonable experience one is able to estimate, in relative terms, the value of a  $+20$  or a  $+30$ ; however, only in the early cases do we accept basal metabolism as a controlling guide for surgical intervention. A patient with Graves' disease with a basal metabolism of  $+60$  may be better clinically and surgically a safer risk than another patient with Graves' disease with a basal metabolism of  $+40$ . We have found it impossible to correlate the basal metabolic readings for the same patient when obtained from different laboratories.

We have on three occasions observed a temporary rise in basal metabolic determinations after a rather extensive resection of both lobes of the thyroid. There are so many emotional factors that may enter into the basal metabolic determinations that it seems unwise to accept this as the one and only controlling factor in indicating when surgery shall be performed.

In this series only one case had a preliminary ligation, as we have felt that with the pre-operative use of iodine we can obtain as much protection for surgical intervention as we could by ligation.

Of the total number of patients, 74 were clinic and 74 were private. In the hyperthyroidism due to Graves' disease 14 per cent. were males and in the hyperthyroidism of adenoma 20 per cent. were males. Myxedema in mild degree following operation for Graves' disease occurred in three out of 56 patients. In two the basal metabolic readings were  $-11$ , and the only symptoms suggesting myxedema were the slight increase in weight and a diminished mental and bodily activity. One of the patients, a male, with a pre-operative basal metabolism of  $+68$ , and a previous history of X-ray therapy, plus large doses of Lugol's solution, in seventeen days dropped to  $-2$ , and six months later to  $-26$ . During this period he gained in weight from 90 pounds to 134 pounds and had a pulse of 90, and at the present time, a little over a year after operation, aside from his minus basal metabolism, gives no evidence of myxedema.

A fourth patient showed severe post-operative myxedema. This patient had two operations for Riedel's struma, subsequent X-ray therapy, and at the present time shows a  $-41$ , with well-marked signs of myxedema. The condition is being ameliorated by intravenous injections of thyroxin.

One case of Graves' disease, with a basal metabolism of  $+42$ , was four months pregnant and had a bilateral thyroidectomy without interruption of her pregnancy. A secondary operation was performed in three cases of Graves' disease for an incomplete "cure." The first patient had a basal metabolism of  $+123$ , which subsequently dropped to  $+52$  after operation and a year later she had a second operation with a drop in basal metabolism to  $+16$ . A second case of Graves' disease, with a pre-operative basal metabolism of  $+64$ , had a regrowth after operation of the left lobe of the thyroid with a basal metabolism of  $+28$ , and eighteen months later was re-operated, with a drop of basal metabolism to normal. This patient subsequently became pregnant and gave birth to a normal child.

Exophthalmos in some degree has persisted after operation in about 20 per cent. of the cases of Graves' disease.

We had a female patient, aged fifty years, who was admitted to the Medical Ward of the Post-Graduate Hospital, with the diagnosis of adenoma of the thyroid, complicated by vertebral metastasis. Upon admission the patient complained of goiter, numbness of the legs and inability to walk. Upon admission her basal metabolism was  $+49$  and under rest and treatment seventeen days later dropped to  $+32$ . The pre-operative diagnosis was multiple nodular adenoma of the thyroid and spinal tumor. A bilateral resection of the thyroid was performed. The pathological diagnosis was "multiple adenoma of the thyroid gland with retrograde changes". Six weeks later a laminectomy was performed by Dr. Byron Stookey for spinal tumor. At operation a round, blood-red protrusion with erosion of the vertebral arch was found beneath the fifth thoracic vertebra. A fairly thorough removal of the tumor was accomplished and the cavity was treated with Zenker's solution. The pathological examination of the spinal tumor showed "metastatic adenoma of the thyroid in vertebra".\* This patient was seen ten months later, was perfectly well and had regained the use of her limbs.

The three mortalities in the group occurred in two females with hyperthyroidism of adenoma, and one in a male with Graves' disease. The first death was that of a woman, fifty-four years of age, with a severe hyperthyroidism, chronic myocardial disease and auricular fibrillation, with a basal metabolism of  $+78$ . This patient was digitalized previous to operation but died suddenly six hours after operation of embolism.

The second death occurred in a male, thirty-four years of age, with Graves' disease. He had been taking large doses of iodine for the previous six months. Under pre-operative treatment, however, he did not adequately respond to rest, digitalis, iodine or morphine. He was prepared for operation in the general surgical ward which, I think, aggravated his condition. He had a basal metabolism of  $+95$  before operation. Following the operation the patient did surprisingly well for forty-eight hours when he developed marked auricular fibrillation and pneumonia, and died on the third day after operation of cardiac failure and pneumonia.

The third case, a woman, fifty-three years of age, with multiple adenomata and severe hyperthyroidism, basal metabolism of  $+73$  auricular fibrillation and chronic Bright's disease, was operated upon under rectal anæsthesia and the operation was performed without any difficulty. After resection of the right lobe the anæsthetist optimistically reported the patient's condition as excellent, and the second lobe was resected. At the termination of the operation the patient suddenly stopped breathing: artificial respiration was employed, but the patient died in the operating room.

Anæsthesia in Graves' disease has represented our most difficult problem. One of the most disturbing elements in the surgery for Graves' disease is the

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\* This case was reported by Dr. Locke L. MacKenzie, in the American Journal of Surgery, March, 1929.



fear and apprehension that is added to the marked nervous disturbance already present. The mere thought of the operation, when it is to be performed, the trip from the ward or room to the operating room, all add a tremendous psychic trauma. To overcome this we have had recourse to rectal anæsthesia in 29 out of 56 cases. This has been most satisfactory, the only objection being the large amount of detail work that is thrown upon the attendants and anæsthetist. Local anæsthesia was not used in any case of Graves' disease. Nitrous oxide was employed once and ethylene-gas anæsthesia in 26 cases.

Recently we have used sodium amytal (Lilly) intravenously which accomplished all that we had sought to arrive at by the more complicated procedure of rectal anæsthesia. Sodium amytal, prepared by Eli Lilly and Company, comes in ampules containing one gram to which is added 10 cubic centimetres of sterile distilled water. After agitating and standing a few minutes a perfectly crystal clear solution should be obtained. Each cubic centimetre of this solution contains 100 milligrams and the injection is made intravenously at the rate of 1 cubic centimetre a minute. The dosage is based upon the range from .020 to .025 per kilo of body weight. We have employed it to produce unconsciousness but not necessarily analgesia. After six to seven minutes the patient is apparently deep in normal slumber and unconscious. The patient is undisturbed for five minutes and then is transported to the operating room. Ethylene anæsthesia is administered and the operation performed. Following the operation the patient has a continuation of an apparently normal slumber and awakens in from two to three hours afterwards. There is no post-operative disturbance and morphine may be used thereafter.

In this series we have had one severe hæmorrhage occurring during the course of the operation from a breaking away of the right inferior thyroid artery. While this hæmorrhage was not lethal, it was dangerous, and the patient was transfused the next day. We have had no post-operative hæmorrhage after the patient left the operating room. We have never packed any of the wounds for hæmorrhage. We had one death on the operating table, just at the conclusion of the thyroidectomy—a woman aged fifty-three years, with chronic nephritis, chronic myocarditis, auricular fibrillation, and basal metabolism of +73. The patient had been taking Lugol's solution, fifteen drops twice a day for eighteen months. The condition was estimated as one of extreme danger. Operation under rectal anæsthesia consisted of a bilateral resection. In the light of reflective experience it would have been wiser to have been satisfied with a resection of one side. The patient had tolerated the resection on the right side with such equanimity, and as the anæsthetist reported the patient's condition as good, the operation was prolonged by resection of the left lobe.

We have always believed that any interference with either the superior or inferior laryngeal nerves during a thyroidectomy would produce an immediate change in the breathing and the sudden development of a stridor. We

have zealously tried in all operative procedures to stop immediately any manœuvre in which the patient responded with any change in breathing sounds or in the character of breathing. In all of our cases we have made a note of the voice sounds immediately upon the patient regaining consciousness. This was noted in the operating room in cases under gas and some time later in cases under ether. This is important as changes in voice or stridor will occasionally develop from twenty-four hours to three months after a thyroidectomy and occur in cases in which there has been neither anatomical or physiological injury to the laryngeal nerves at the time of operation.

We have had three cases in which voice complications developed. This complication is strongly contrasted in the following two cases:

Mrs. M. was operated under ethylene for a large adenoma. At the conclusion of the operation the breathing was normal, the breath sounds full, deep and ample. Patient was discharged at the end of nine days, and six weeks later reported at the clinic with hoarseness and stridor and some difficulty in breathing. Laryngeal examination showed a paralysis of the left vocal cord. At the end of four months this patient had recovered her voice and the stridor had disappeared, but under any unusual vocal exertion she becomes somewhat hoarse. Mrs. K. was operated upon for multiple adenomata and during the dislocation of a large substernal goiter she developed a slight stridor. Manipulations were stopped immediately and after a momentary rest the approach was made from a different angle. At the conclusion of the operation the patient had a slight hoarseness and in the course of the next seventy-two hours developed considerable stridor, which persisted for about two weeks, never dangerous, nor of sufficient loudness to disturb the adjacent patients. At the end of six weeks she slowly began to improve in voice and lost the stridor. At the present time she has regained about 80 per cent. of her normal vocal capacity. Undoubtedly a physiological injury was inflicted upon the recurrent laryngeal nerve, for a laryngological examination on the fifth day showed a cadaveric left cord.

The development of a severe post-operative tracheitis is an annoying complication and has occurred in a few cases. It is apt to be confused with nerve injury. It occurred in four of our patients who had sustained a rather close dissection of the thyroid from the trachea. In two of them the size of the tumor had caused marked lateral displacement of the trachea. Voice sounds at the termination of the operation and breathing sounds were apparently normal. At the end of twenty-four hours there developed aphonia, marked difficulty in breathing, with stridor, and in two cases it was deemed wise to re-open the wound in the neck, with almost an immediate improvement and subsequent recovery.

In this series tracheotomy was only performed once, in a man that I presented before this Society, and it is the only case that convinced me that such a thing as tracheal collapse could occur.

Most of the complications and difficulties in thyroid surgery are due to the technic employed. In the earlier cases we divided the pre-thyroid muscles on both sides and attempted to mobilize and elevate the gland with the result that we had more trouble from hæmorrhage, from temporary breathing difficulties than in the latter part of the series, when we adopted as a uniform

procedure two definite types of technic. In the retrosternal goiter we first ligate and divide the superior pole. We prefer to ligate the individual vessels rather than use a mass ligature. After division of the superior pole the isthmus is divided in the median line with the result that the goiter is rolled, as it were, from its bed downward and forward over the chest and so out of the superior thoracic aperture. In the other goiters, we have at the beginning, divided the isthmus, then ligated and divided the superior pole and by gentle traction forward and outward have then been able to place hemostats along the lateral surface of the thyroid lobe, thereby clamping the veins that enter and leave the thyroid. In addition, the hemostats laterally give the operator a guide to the point where the resection will terminate so that the posterior capsule, the blood supply to the parathyroids and the nerves are neither exposed, manipulated nor disturbed. This results in the excision of a wedge of thyroid tissue on either side, leaving a thin film of thyroid tissue over the trachea. The result of these procedures has been to simplify the operation, permits early control of the bleeding and insures a much smoother operative technic.

## CONCLUSION

Total number of operations .....	148
Total number of patients .....	144
Number of re-operated cases .....	4
Post-operative mortality .....	3
General anæsthesia .....	1
Rectal anæsthesia .....	29
Ethylene anæsthesia .....	115
Nitrous oxide anæsthesia .....	3
Basal metabolism	
Highest .....	+114
Lowest .....	+3
Average .....	+45
Hyperthyroidism of adolescence .....	3
Hyperthyroidism of Graves' disease .....	56
Hyperthyroidism of adenoma .....	36
Colloid goiter .....	24
Non-toxic adenoma .....	21
Malignant .....	5
Riedel's struma .....	2
Tuberculosis .....	1
Average stay in hospital .....	10 days
Average pre-operative stay in hospital .....	4 days
Average post-operative stay in hospital .....	6 days

# MESENTERIC CYSTS

WITH REPORT OF CASE OF CYSTIC LYMPHANGIOMA

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OF DALLAS, TEXAS

FROM THE BAYLOR UNIVERSITY MEDICAL SCHOOL

THE purpose of this paper is to report a case of cystic lymphangioma of the mesentery, unusual in size, attachment and character. In making this report I shall briefly review the literature pertaining to this condition and make certain comments based on my personal experience in studying this particular case.

Mesenteric tumors are among the rarest tumors met with in the abdomen. Mesenteric cysts are more common than the solid mesenteric tumors. However, not more than two or three hundred cases of mesenteric cysts have been reported in all medical literature. This paper is confined to the subject of mesenteric cysts. It is not unusual for surgeons of wide experience to conclude their active surgical careers without ever having seen one. It is an interesting fact that in all the medical literature to which I have had access is reported no single instance where the diagnosis of this condition has been definitely and correctly made previous to operation or autopsy.

Nothing really new has been published in the many excellent papers of recent years. From the literature on the subject it appears that the condition was first described by Rokitansky in 1842, although a case had undoubtedly been observed as early as 1507 by Benevieni. It was not until 1897, that Moynihan attempted to give a workable classification of these tumors. However, great scientific interest in mesenteric cysts was first aroused by Dowd, who published an admirable monograph emphasizing the embryonic origin of most of these cysts and reported a relatively large series of cases collected from the literature. He suggested a very simple classification based upon the origin of these cysts as follows: 1, embryonic cysts; 2, hydatid cysts; and 3, cystic malignant disease. Many authors have elaborated on Dowd's classification but perhaps it is only Niosi (1907) who has improved thereon to any extent by his amplification of the classification of mesenteric cysts of *embryonic* origin as follows: (a) cysts of intestinal origin; (b) dermoid cysts; (c) cysts arising from retroperitoneal organs, *viz.*, urogenital organs.

Ewing, in his book on *Neoplastic Diseases*, for the convenience of pathologists divides these tumors into four main varieties. First, lymphatic or chylous cysts; second, enteric cysts; third, urogenital cysts; and fourth, dermoid and teratoid cysts. He emphasizes the difficulty with which hydatid cysts and cysts of neighboring organs are differentiated clinically from mesenteric cysts. His report of the subject I shall take the liberty of briefly abstracting.

1. *Chylous cysts* develop either as very large, simple, usually multilocular tumors, or as numerous small swellings of the mesentery, omentum, intestinal wall and retroperitoneal region. The contents are clear fluid or chyle or more inspissated fatty material, and blood is often present. The walls are fibrous tissue in which are many round-cells or lymph follicles, and in the walls are often dilated lymph spaces. The lining is of endothelium and it may be hyperplastic, or it may have undergone degeneration and have disappeared here and there. Klemm and Rittner (Ewing) interpret all mesenteric chylous cysts as cystic lymphangioma and it is in this group that the case hereinafter to be reported is included. That some of these cystic lymphangioma represent merely dilated lymphatics, however, is shown by Kostlivy's (Ewing) study and by the cases of lymph cyst arising after occlusion of local lymphatics in cancer.

2. *Enteric cysts* are intraperitoneal cysts. They form (Ewing) as single or multiple large or small cysts, along the lower end of the ileum in the wall of the intestine, or at the point of Meckel's diverticulum (Roth), or in the mesentery, or near the navel (Wyss). When originating within the muscular wall of the intestine they usually remain connected with this organ and are enclosed by a muscular wall. The cyst wall resembles that of the intestine and has a lining of epithelium.

3. *Urogenital cysts*.—Intraperitoneal cysts of nephrogenic origin are rare (Ewing). Niosi collected five cases. These cysts, of large size, single or multilocular, involve the mesentery and adjacent regions, or extend into the pelvis. They occur chiefly in adult women. The contents are brownish, serous fluid, containing pseudomucin. The wall is composed of fibrous tissue and the lining is of high cylindrical or cuboidal glandular epithelium. The origin of these cysts is not definitely known.

4. *Dermoid and teratoid cysts* of the mesentery and peritoneum are rare (Niosi). They are located in any portion of the mesentery from coeliac axis to pelvis, and their dimensions may be considerable. Peritoneal teratoid cysts are even more rare than dermoid cysts.

*Occurrence*.—Mesenteric cysts occur most commonly in the third decade of life, although case reports of this condition in infants four months of age and in octogenarians are on record. These cysts develop more often in women than in men, and occur to the right of the median line and below the navel in a very large majority of cases. Trauma is given as an important etiological factor in many case reports.

*Complications*.—Swartley, of Philadelphia, in May, 1927, in an excellent paper brought the bibliography and such new thoughts on the subject as have developed in recent years, up-to-date. He mentions intestinal obstruction as the most frequent and the most serious complication of this disease. In various collected reports the incidence of intestinal obstruction appears to be approximately 50 per cent., and the mortality from this complication ranges from 35 to 50 per cent. Swartley is of the opinion that obstruction is due to mechanical causes, such as, narrowing of the lumen of the bowel from the immense size of the tumor, volvulus, intussusception, kinking, and adhesions from pressure of the tumor. He notes as other complications the following: peritonitis, which is usually a sequel of obstruction; hæmorrhage into the cyst; rupture of the cyst; and torsion.

*Symptoms and diagnosis*.—There are no characteristic symptoms or signs of mesenteric cyst, and this has made the differential diagnosis, even where such cyst is suspected, very difficult. In consequence, as heretofore stated, no case of mesenteric cyst has been reported as correctly diagnosed previous

to operation or autopsy. However, one should at least suspect mesenteric cyst if there be observed an abdominal tumor, smooth, rounded, apparently cystic and freely movable, in an otherwise healthy individual, particularly a female, who has undergone recurrent attacks of abdominal pain later associated with nausea and perhaps vomiting, and the examination has established that the pelvic organs are not affected. These patients may have severe constipation or they may have diarrhoea alternating with constipation. Evidently there is sufficient embarrassment of the bowel to produce obstruction of the lumen and therefore increased peristaltic activity above the attachment of the tumor. None of these patients waste as do patients suffering from malignant tumors; in fact, many of them gain in weight. Occasionally the presence of a palpable tumor in the abdomen, even though the patient has no symptoms of any sort, brings the patient thus afflicted to the surgeon. If for any reason the tumor has become inflamed when the case is first observed, extreme care must be given to differential diagnosis so as to distinguish such tumor from the usual acute abdominal conditions, such as acute appendicitis, acute intestinal obstruction, ovarian cyst with a twisted pedicle, retroperitoneal growth, movable kidney, pancreatic cyst and new growth of the intestine with secondary infection. Strangely enough instances are reported wherein the presence of such cysts has been mistaken for pregnancy.

I am of the opinion that the case reported has rather a typical history, which is as follows:

**CASE REPORT.**—D. W., white girl, sixteen years of age, was admitted to Baylor Hospital the night of November 10, 1928. She was acutely ill; temperature 102°; pulse 140; respiration 24. She complained of first, pain in abdomen; second, nausea; third, no evacuation of bowels for three days; fourth, abdominal distention, tenderness and rigidity; fifth, general malaise.

*Past medical history.*—About six years ago, she received a severe blow in the upper left abdominal quadrant which caused her great pain and suffering for about four days. She has felt, since that time, that there was something wrong in that portion of her abdomen. She has always been a very active, healthy child, doing more than her share in work and play. Following recurrent attacks of tonsillitis, her tonsils were removed several years ago. About one year ago, her mother first noticed that her abdomen was enlarging, and she was gaining weight though exercising vigorously. It was at this time that she began to feel a definite sense of fatigue following even moderate exercise. She has suffered from constipation since infancy.

*Menstrual history.*—Menses began at fourteen years of age, always very irregular, periods coming at intervals of three and four months; the flow always profuse, lasting four to ten days. No cramping or other discomfort associated with menstrual period.

*Family history.*—Mother, father, two brothers and one sister living and well.

*History of present illness.*—Patient for several weeks has had attacks of cramping pain associated with nausea, the pain being severe and present particularly in the iliac fossæ. She has felt tired and when walking she has been conscious of a heavy weighty feeling in her abdomen pulling her forward. She has never vomited, and the cramping ordinarily lasted about four days. Her abdominal muscles are rigid and she has difficulty in straightening up. The most severe attack, previous to the present one, was four weeks ago. Her bowels move only after purgation. In the interval between the attack four weeks ago and the attack which came on forty-eight hours ago, she has felt fairly well, except that she has felt lazy and disinterested in things which ordinarily would

interest her. She has played tennis, danced, and has not missed a period in the gymnasium during the school year. Forty-eight hours ago, she finished her gymnasium work and decided to walk. This she did, walking about four miles, and returned home exhausted, nauseated, and with a severe pain in her abdomen. The pain and soreness has continued for two days, associated with nausea, abdominal-muscular rigidity, and severe constipation. The pain in her abdomen is aggravated by lying on her back.

*Physical examination.*—She lies quietly in bed, not complaining except when disturbed. The examination of the head, neck and chest is entirely negative. The abdomen is rigid and distended. Liver dulness and splenic dulness are continuous with dulness in the abdomen. It is impossible to palpate the margin of the liver or the spleen. Even though there is marked distention and rigidity it is possible to introduce the examining fingers rather deeply into the abdomen just above the brim of the pelvis. Palpation of the abdomen reveals marked resistance over the whole anterior abdominal wall, more

like an inflammatory process than a tumor. However, that exquisite tenderness to sharp palpation characteristic of acute inflammation is absent. Bimanual examination of the pelvis is negative; the uterus is small and the adnexæ seem normal. Blood analysis shows a leucocyte count of 16,000; polymorphonuclear leucocytes 83 per cent.; small lymphocytes 11 per cent.; large lymphocytes 5 per cent.; transitionals 1 per cent. Urinalysis: specific gravity 1.015; negative for sugar, albumen and pus. Blood Wassermann, made the following day, is negative.



FIG. 1.—Photograph of tumor measuring  $9\frac{1}{2}$  inches by 8 inches by 4 inches. Note cystic areas on surface, together with small grayish elevations, some old blood and fibrinous exudate on surface.

Diagnosis.—I regret that a pneumoperitoneum could not be done, as I believe that in less acute situations very definite information might be obtained in this way. After two days' acute illness with appendicitis and peritonitis, or peritonitis from some other cause, one should expect to find a patient obviously very sick with nausea and vomiting, apprehensive, and with other evidences of a severe toxæmia. Almost the opposite of this picture was found in this case. I was unable to outline a tumor, although the resistance to palpation suggested such a condition. I felt sure that there was not a localized abscess in the right lower quadrant. I palpated the uterus and adnexæ and thereby ruled out a pelvic tumor. I could not make a definite diagnosis, but felt that the patient had some acute inflammatory condition in her abdomen producing obstruction of the bowel, and advised an immediate abdominal exploration.

*Operation.*—Under ether anæsthesia a right rectus incision, four inches long, was made. When the peritoneum was opened a large amount of very dark blood, under pressure, was released. A rapid exploration was made and I determined that I was dealing with a tumor, originating in the left upper quadrant and extending obliquely across the abdomen into the right iliac fossa. The tumor (Fig. 1) practically filled the abdomen. The incision was lengthened above and below until I was able to deliver the tumor. This required an incision the full length of the rectus muscle, and this

incision gave excellent exposure. I found that the pedicle of the tumor was about four inches across, and was attached to the mesentery of the first portion of the jejunum immediately distal to the ligament of Treitz. The blood supply to that portion of the jejunum passed directly through the tumor attachment; the base of the pedicle extended to the posterior body wall; however, the base of the pedicle did not include the bowel wall. The problem with which I was face to face was obviously difficult. I first attempted to dissect the pedicle free of the mesentery and found that this was impossible without injury to the circulation of the bowel. I then decided that a resection of a considerable portion of the jejunum together with the tumor was the only solution. There were no enlarged lymph glands in other portions of the mesentery or the great omentum. The bowel was clamped just below the ligament of Treitz and also beyond the tumor, and the intervening portion was resected together with the pedicle of the tumor. A complete operation removing all affected tissue together with forty inches of bowel was accomplished. The bowel was reunited by end-to-end anastomosis and the abdomen closed without drainage. In the post-operative treatment glucose intravenously and normal saline solution subcutaneously were given at intervals for three days, and



FIG. 2.—Drawing of mesenteric tumor  $9\frac{1}{2}$  by 8 by 4 inches, together with resected bowel. Note irregular surface varying from small cysts to dense fibrous tissue.

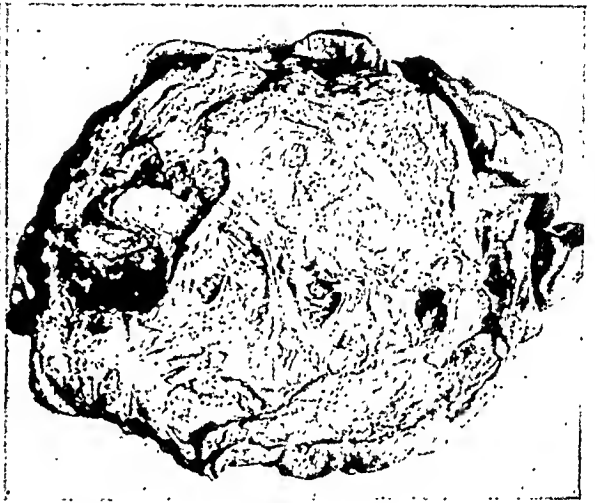


FIG. 3.—Photograph of bisected tumor showing cystic areas and dense fibrous tissue stroma.

in consequence there was neither a decrease in chlorides nor the development of an acidosis. The patient made an uneventful recovery and was up in a wheel chair on the fourteenth day. Two days later, November 27, 1928, she was discharged from the hospital and resumed her school work four weeks after the operation. She has been examined recently and it has been determined that the wound has healed, that she has gained several pounds in weight, and that apparently she is in perfect health.

*Gross description of tumor.*—The tumor was firm with irregular surface and margins and measured  $9\frac{1}{2}$  by 8 by 4 inches. Its color was dark blue and there was considerable oozing from its surface. Many small, soft areas on the surface resembled dilated veins, and were easily ruptured and contained a dark, viscid material. The bowel attached to the tumor measured 40 inches.

*Tissue report by Dr. M. T. Richardson. Gross appearance.*—Specimen consists of tumor measuring 20 by 12 by 12 centimetres (specimen has been in ice box for forty-eight hours). Is dark red in places, gray in others, irregular in outline, apparently cystic on outer surface, shows presence of numerous small gray elevations (Figs. 2 and 3). There is attached about 74 centimetres of small intestine. This is attached to tumor by mesentery. There are no enlarged mesentery glands. On section, tumor cuts with little resistance and seems to be composed of numerous cystic spaces containing salmon-colored turbid fluid, some blood clots, and friable material suggesting fibrin. In



general the tumor is trabeculated in appearance. Cystic spaces have smooth lining, best seen following removal of fibrin-like material. Color varies from gray to pink and dark red (Figs 4 and 5.)

*Microscopical findings*.—Section of tumor shows numerous channels of varying size, some of which are collapsed and only in small parts containing blood-vessels. Between these there is considerable oedematous connective tissue, in which is an infiltration of lymphocytes. Also, in areas in stroma there are large cells, apparently endothelial, whose cytoplasm contains numerous vacuoles of varying size together with slight amount of finely granular brown pigments. Channels are for the most part lined by flattened endothelium.

*Pathological diagnosis*.—Lymphangioma.

*Treatment*.—The treatment of mesenteric cysts is always surgical and the condition usually requires an emergency operation. Five methods have been

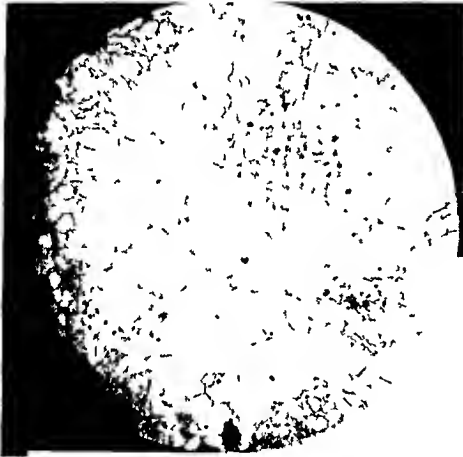


FIG 4—Microphotograph (low power) showing cystic areas in channels of varying size. Between these there is oedematous connective tissue, in which is an infiltration of lymphocytes.

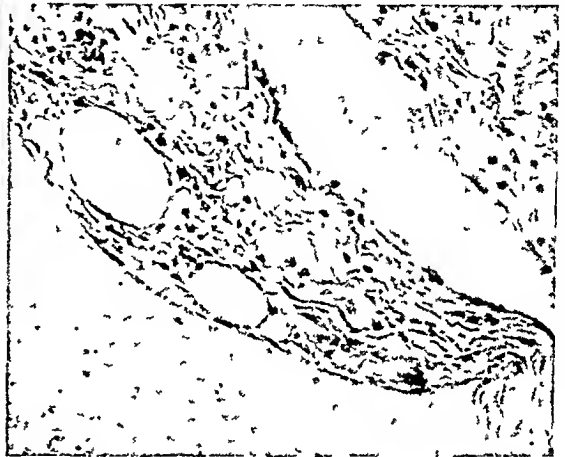


FIG 5—Microphotograph (high power) of tumor showing large endothelial cells in stroma. Channels lined by flattened endothelium. Also shows type of material in cysts.

used in the treatment of mesenteric cysts. 1, aspiration; 2, marsupialization; 3, drainage; 4, enucleation; 5, resection.

1. Aspiration is a method which should never be used, as it has been demonstrated to be wholly unsatisfactory.

2. Marsupialization is only applicable in cases of hydatid cysts or of very large unilocular cysts where removal of the tumor is extremely hazardous.

3. Drainage in selected cases may suffice and the mortality is only about 6 per cent. Unfortunately a persisting sinus often calls for resection later.

4. Enucleation is the best method provided its use is feasible. The mortality is about 16 per cent. Where the tumor can be completely removed this method gives excellent results.

5. Resection is the method indicated in most instances, especially if the tumor is so large or is so attached that the circulation of the bowel is interfered with in an attempt to remove the tumor by other methods. The mortality is about 60 per cent. This high operative mortality is in part explained by the fact that in many cases requiring resection, the patient has

already developed intestinal obstruction of some degree, and frequently has a local peritonitis.

*Prognosis.*—Although mesenteric cysts are benign tumors, the prognosis depends on the size, location and site of attachment of the tumor, and to a still greater extent on the time at which the diagnosis is made and operation carried out. The outcome is also largely dependent upon whether the tumor can be removed by one of the less serious surgical procedures such as enucleation, or by one of the more serious operations such as resection. The presence of intestinal obstruction or peritonitis, so frequently observed in cases operated as an emergency, makes the primary mortality very high.

*Summary.*—The case reported is of interest because of the rarity of mesenteric cysts. The symptoms were rather typical. A positive diagnosis was not made. The tumor was an unusually large one and bore out Keen's suggestion that the size of the tumor and the pressure resulting therefrom, usually explain the symptoms. The tumor was firm, but contained many small cysts lined with endothelium and turbid fluid. Some of these cysts were collapsed and others contained connective tissue. The tumor is a lymphangioma, cystic in type, but apparently a firmer tumor than most authors have hitherto described. The repeated attacks of cramp colic and the marked constipation heralded an oncoming intestinal obstruction. There were no glands enlarged in the mesentery, therefore it is reasonable to believe that there was no tuberculous phase to the condition. It is also interesting to note that this tumor developed from the first portion of the mesentery of the jejunum. Resection of a large section of the jejunum together with the tumor seemed necessary and was carried out with success, as is evidenced by the patient enjoying perfect health thirteen months after operation.

## CONCLUSIONS

1. Since the reported case came under my observation, I have become convinced that the condition is more common than is generally thought. I am sure that many mesenteric cysts have been observed or removed and the character of the tumor not suspected. I have knowledge of a number of tumors removed or observed by my colleagues which I am inclined to believe were mesenteric cysts.

2. The high mortality in the treatment of this condition is due to the late recognition of the disease, usually during an emergency operation, at which time the serious complications of intestinal obstruction and peritonitis have already developed. Under such circumstances, resection of the bowel naturally carries with it a very high primary mortality.

3. These tumors are sufficiently common to justify consideration of the condition whenever an abdominal tumor is observed. The symptoms and signs are not characteristic and the diagnosis must be made by the exclusion of the more common tumors met with in the abdomen.

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# EFFICIENCY OF THE VARIOUS TYPES OF ANASTOMOSES OF THE HOLLOW VISCERA

CLINICAL AND EXPERIMENTAL DATA

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I. EXPERIMENTAL WORK.—The efficiency of an anastomosis in experimental work on dogs can only be tested by the effect it has on the animal's nutrition. Obviously, in dogs we cannot observe the results of an anastomosis performed for diseases of the gastrointestinal tract similar to those which occur in man. In the lower animals we have depended on two factors to tell us whether an anastomosis was efficient: first, the X-ray; and second, the state of the function of nutrition of the animal.

Every type of gastrointestinal anastomosis was performed in our experiments. They included a Billroth No. 1 and No. 2, posterior gastroenterostomy, a Finney and Horsley, and the massive resection of the stomach followed by the Polya type of anastomosis or a posterior gastroenterostomy. While we performed the Finney and Horsley operations on the dog, their field of usefulness as applied to man is quite limited. In all instances X-rays were taken before and after operation. Unfortunately, when we performed a Billroth No. 2 or a resection of the stomach, enough time was not at our command to make an X-ray study of the operative field because in almost every instance the dog succumbed.

Physiological differences were noted when we performed a Billroth No. 1 and No. 2. Death was not due to any error in technic, resulting in peritonitis, intestinal obstruction or hæmorrhage following a Billroth No. 2 operation. Nothing gross could be detected to account for the death of the dog within five or six days following the operation. These operations were performed by means of a simple severance of the duodenum distal to the pylorus or a piece of duodenum was excised. In any event, both ends were closed and a posterior gastroenterostomy was performed. While explaining our experience to Bassler, he confirmed our observations, though he could not give us any adequate explanation for the death of these animals. Recently we repeated our experiments again to prove our contention that animals operated upon by the Billroth No. 2 method died. The result was the same.

Much has been written recently on a deficiency of chlorides which probably is an effort on the part of the body to maintain a normal acid-base equilibrium. We examined the blood of the dog for the estimation of the chlorides. While they were lower than before operation, there was not enough reduction to cause the death of the animal. Again, in our operation on the dog we did not interfere with the normal peristalsis. About six inches

away from the closure of the duodenum we attached the stomach to it which left a proximal pouch of the duodenum.

If the dog survived the operation it made practically no difference at all as to the type of operation which was performed. A few days after operation their appetites returned and they regained their former weight in a comparatively short time. The anastomoses were all efficient and one had no choice as to the so-called best operation from which to choose.

An X-ray of the normal stomach of the dog can well be compared to those taken in man. The anatomical relations are much the same, notwithstanding the fact that the animal walks on all fours. The stomach in the dog lies transversely to the long axis of the body. The pylorus is well defined and the duodenum follows on as in man, with the pancreas in the same anatomical relations as well. While in some of the X-rays the normal stomach is much shaped like a ball, in actual life this is not the case.

As stated before, little opportunity is given the observer to study the results of anastomoses in the dog where there has been an excision of part of the stomach followed by a posterior gastroenterostomy. We have observed, however, that if we perform a Billroth No. 2 sometime after a Billroth No. 1, a tolerance has been created in the animal after which he is more likely to survive a resection of the stomach.

2. CLINICAL WORK.—It is difficult to make comparisons of the efficiency of the various gastrointestinal anastomoses between those performed on man and animals because the reasons for doing these operations are so dissimilar. Only the physical results can be compared. In man an anastomosis is performed for some serious diseased condition of the hollow viscera. In fact, no one at present would do a gastroenterostomy, for instance, on the possible existence of an ulcer. There must be a demonstrable lesion before the patient is subjected to such a serious operation. In the dog, however, we are not confronted by diseased conditions; we are only interested in the results obtained from a study of the mechanical efficiency of the anastomosis.

Our primary object of pursuing this study was an attempt to help clear the horizon, if this be possible, of the still unsettled question as to the kind of operation to be performed in certain diseased states of the hollow viscera, with special reference to ulcer of the stomach and duodenum. In the minds of some surgeons there is a fixed idea as to the type of operation that should be performed in patients having a chronic gastric duodenal ulcer. To me it seems unwise to have any preconceived idea as to the kind of operation to be performed before the abdomen is opened and the lesions inspected and palpated. By means of palpation and inspection alone is it possible to determine the character of operation to be performed in the best interest of the patient.

The dogmatic statement and practice that a gastric resection should be performed on every patient suffering from a chronic gastric and duodenal ulcer is, to say the least, poor judgment. I advocate and perform the massive resection of the stomach in selected cases. I have had occasion to employ

this operation for duodenal and pyloric ulcers. I would not advise its universal application in all cases. In support of this operation I must say that the convalescence in the successful cases is all that can be desired, while the ultimate results are very good. Symptomatically, these patients who have had the massive resection performed are free from some of the disturbances following posterior gastroenterostomy. I do not deny that there is a large field of usefulness for the latter operation. The success or failure of a gastroenterostomy depends in part on the location and size of the stoma. Whenever we are able to select a site for the anastomosis it should be placed not directly under the cardiac end of the stomach nor should there be any tension on the proximal duodeno-jejunal junction. Occasions arise when the selective point for the anastomosis cannot be chosen, especially where a previous operation has been performed, or where the stomach has been cicatrized and distorted due to ulcers on its borders and walls.

*The efficiency of an anastomosis also depends on the size of the stoma.* Our object should always be to have a stoma large enough to admit the index finger and the thumb, so that they can readily meet, the walls of the anastomosis naturally intervening. If the stoma is placed under the cardiac end of the stomach, the food has a tendency to drop into the jejunum. This, in turn, may cause diarrhoea immediately after eating.

With the working efficiency of an anastomosis are naturally linked morbidity and mortality. When we speak of morbidity, we have in mind unpleasant symptoms that arise after an anastomosis has been performed, or the sequence of an ulcer occurring at the site of anastomosis. On comparing the various anastomoses, it is often stated that ulcers occur most frequently after a posterior gastroenterostomy than after massive resection of the stomach. As a matter of fact jejunal ulcers occur after both types of operations, but their frequency is so negligible as not to influence us in the selection of one kind of operation over another.

Naturally, the mortality after a posterior gastroenterostomy should be lower than after a gastrectomy, provided the latter is well planned and executed.

We have selected a few cases to demonstrate that all the various anastomoses we perform are efficient from the mechanical standpoint, provided we place the stoma in the proper position and without a loop formed by the attachment of the jejunum to the stomach. In favorable post-operative symptomless patients their health does not depend on the fact that they have had a posterior gastroenterostomy or a resection of the stomach or a resection followed by the Polya technic. To this class without symptoms belongs the great majority of patients operated upon.

After these generalizations on anastomoses, let us turn to the specific cases under consideration. Each was operated upon in the Jewish Hospital.

CASE I.—A woman, M. C., aged thirty-five years, was admitted April 19, 1920. She complained of pain intermittent in character. The pain began in the epigastric region and radiated to the back. Forced vomiting relieved pain. Operation revealed an ulcer

on the posterior wall of the stomach adherent to the pancreas. We opened the stomach, sewed the mucous membrane over the ulcer and performed a posterior gastroenterostomy. Five years later she again developed symptoms. The ulcer was then excised without disturbing the anastomosis. Some of the opaque meal passed through the anastomosis, but "during this time more of the meal is seen to escape from the stomach through the pylorus." Since the last operation the patient has enjoyed good health.

CASE II.—A male, C. H., aged forty-eight years, admitted December 9, 1921, for hæmatemesis. Indigestion for some time. Radiographs showed an ulcer on the lesser curvature at the pylorus. The pylorus was excised and a Billroth No. 2 operation was performed. A recent X-ray shows "the stomach lying high in the abdomen. No retention of the meal was seen after a six-hour period. Pyloric cap is absent. The barium meal flows freely through an opening in the posterior portion of the stomach." He has never had a symptom since his discharge from the hospital.

CASE III.—A rather remarkable case, that of a man, M. H. S., seventy-three years old. Admitted February 26, 1923. He complained of gastric disturbances. In addition, he was jaundiced. Abdominal examination revealed a mass in the epigastric region. When the abdomen was opened we found a rather large tumor of the stomach with a secondary growth in the pancreas, obstructing the common bile duct. A diagnosis of carcinoma of the stomach and pancreas was made. Resection was out of the question. We contented ourselves with a posterior gastroenterostomy and an anastomosis of the gall-bladder to the stomach. The operation relieved him of all his symptoms. He is well today, five years after the operation. An X-ray study now shows "the stomach lying high in the abdomen. A very small quantity of the opaque meal passes through the pyloric cap. Most of it passes through an opening in the posterior wall of the stomach. No retention is seen after the usual emptying time. Nothing abnormal is noticed at the gastroenterostomy opening."

The simplest form of operation for the relief of symptoms is a posterior gastroenterostomy. We are often compelled to do this operation on account of the poor physical condition of the patient. This circumstance may be caused by hæmorrhage and a fear to eat, causing great emaciation and anæmia. This is the type of case in which, after opening the abdomen, it is difficult to differentiate between a chronic gastric ulcer and carcinoma. The following illustrates this type.

CASE IV.—A man, T. I. W., aged fifty-one years, admitted February 10, 1926, told us he was perfectly well up to three months ago, when he began to have pain after eating. He vomited once a day, the vomitus being coffee-ground material. He was extremely emaciated. A diagnosis of pyloric carcinoma was made. A posterior gastroenterostomy was the sole operation performed. The growth at the pylorus was not removed on account of the precarious condition of the patient. The liver showed a few nodules resembling metastasis. Microscopically, these were benign. This man comes to our follow-up clinic looking well and symptomless. He refused to come for a recent X-ray.

A series of massive resections of the stomach followed by posterior gastroenterostomies or the Polya operation are next to be considered. A gastrectomy or the so-called Finsterer operation was performed in some cases for duodenal ulcer. Here is probably the greatest cause for controversy between those who advocate simple posterior gastroenterostomy with the excision of the ulcer and those who prefer the massive resection of the stomach, reference to which mention has already been made above.



Suffice it to say that I have been much gratified with the immediate convalescence and the ultimate cure of the patients on whom I have performed the Finsterer operation.

CASE V.—A woman, S. G., aged forty-two years, admitted December 5, 1924. She complained of pain in the epigastrium. She was perfectly well up to July, 1924, when she had an attack of severe pain in the mid-epigastrium. Pain was relieved after eating. At operation a portion of the duodenum, including the ulcer and a large portion of the stomach, was removed. The radiograph shows that the "stomach is empty after the ingestion of an opaque meal." On account of the rapid progress of the barium column there is intestinal hypermobility.

The next two cases illustrate different types of operation for gastric ulcer. In one, we resected a large portion of the stomach and performed a posterior gastroenterostomy. In the other, the Polya operation served a better purpose, because very little of the stomach remained after operation.

CASE VI.—A male, H. A. M., aged forty-nine years, was admitted April 15, 1925. He complained of pain after eating. The pain began two or three hours after meals. He forced himself to vomit, after which he felt relieved. He lost twenty pounds in two months. In this patient the stomach was resected and the gastric and the duodenal ends were closed. A posterior gastroenterostomy completed the technic. The radiologist reports that "five hours after the ingestion of an opaque meal at least one quarter of it was still in the stomach. There is apparently a gastroenterostomy opening through which practically all of the opaque meal leaving the stomach goes."

In the next patient with ulcer of the stomach, we performed a Polya operation after resection of the stomach.

CASE VII.—A male, S. R., aged fifty-nine years, admitted April 6, 1926. He complained of vomiting which began ten years ago. It recurred four years later, then subsided, and reappeared three years ago. The patient was free of symptoms until three weeks previous to operation when the vomiting occurred again, coming on one and a half hours after meals. He was quite emaciated. When the abdomen was opened there seemed to be a possible malignancy. A large resection was performed, a loop of jejunum was brought up through the transverse mesocolon to the cut end of the stomach. Today, the radiologic report reads, "No retention of the opaque meal is seen after the usual emptying time. Within a half an hour the stomach is completely empty. The pyloric cap cannot be outlined."

The last illustrative case in this group of gastric resections is remarkable because of the extensive carcinoma that existed in the stomach and also because of the complete ultimate recovery of the patient.

CASE VIII.—E. S., a man aged seventy-one years, admitted March 5, 1926. He complained of pain in the upper right abdomen. He had vomited for three weeks. After this the pain became quite severe, necessitating his removal to the hospital. At operation a large mass obstructing the pylorus was found. A massive resection was followed by a Polya operation. The patient developed complete retention of urine for which a suprapubic cystotomy was done. The prostate was not removed as he regained the normal urinary function. The pathologist reported mucoid carcinoma of the pylorus. The radiologist says that, "six hours after the ingestion of an opaque meal, the stomach still contains half of it. Eight ounces of the opaque solution were administered and what is apparently the stomach was fully distended. The opaque meal escapes from the

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stomach through a narrow orifice at its superior and right corner. Peristaltic waves were quite vigorous, but rather ineffectual." This patient returned to work again as a machinist.

All the patients reported are living in a fine degree of comfort, symptomless and possessing an efficient anastomosis.

Finally, it has been our experience that it makes very little difference concerning the kind of anastomosis made, so long as the stoma is properly placed and of the right size. Again the anastomoses in the main have been lateral or end-to-side, depending on the nature of the lesion for which the anastomosis was made. We have made practically no use of the Finney or Horsley operations, although in our experimental work we performed these operations and found them efficient. Physiologically, the end-to-end anastomosis is the proper one to perform, but it has little application in gastric surgery. Even a Billroth No. 1 has its limitations.

In conclusion, we have found that while we can perform all anastomoses on the dog within certain limitations, their efficiency can well be compared to those performed in man.

Our limitations in performing gastrointestinal anastomoses on the dog are due to the fact that most of our dogs died when we performed a Billroth No. 2 operation.

The resistance of the dog can be enhanced if we perform a Billroth No. 1 first, and then at some future time perform a Billroth No. 2.

Dogs in which a gastroenterostomy has been performed without any resection survive the operation and grow fat after an efficient anastomosis.

Comparison of functional results only can be made between the anastomoses performed in the dog and in man.

In man all the various anastomoses performed for gastrointestinal conditions have been found efficient.

The efficiency depends on the placement and size of the stoma.

The massive resection of the stomach and the operation of the posterior gastroenterostomy have their field of usefulness in selected cases.

My thanks are due to Dr. Sidney Feldstein, radiologist to the Jewish Hospital and my co-workers, Drs. Clinton S. Herrman, Victor A. Loeb, Maurice Winston, and Morris Segal.

# OPERATIVE RESULTS IN PARTIAL AND SUBTOTAL GASTRECTOMY FOR GASTRO-DUODENAL ULCERS

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THIS paper is a report of my operative results following partial and subtotal gastrectomy for gastro-duodenal ulcers.

I have two reasons for presenting this subject at the present time.

(1) For many years I have been a strong advocate of these radical procedures and have expressed my views on this subject in a number of papers.<sup>1, 2, 3, 4, 5, 6, 7</sup> I have claimed repeatedly that the mortality following partial and subtotal gastrectomy in gastro-duodenal ulcers compares favorably with the death rates following conservative measures. Having used this procedure as the method of choice for six years I feel that sufficient time has elapsed to prove this claim by a statistical report.

TABLE I

*Mortality in sixty-nine cases of primary and secondary gastric resections*

Total mortality (primary and secondary Operations):.....	69 cases	12 + *	(17%)
Mortality—primary operations, (including acute bleeding ulcers):.....	56 cases	6 +	(10%)
Mortality—chronic ulcers:.....	51 cases	4 +	(7%)
Billroth I: 1923.....	3 cases	0 +	
Finsterer: 1923.....	2 cases	1 +	
Antecolic B II: 1922 and 1923:.....	2 cases	2 +	
Retrocolic B II: 1920-1928:.....	44 cases	1 +	
Mortality—retrocolic B II chronic ulcers.....	44 cases	1 +	(2, 27%)

\* + = died.

(2) For a number of years I held the position of Associate on the Service of Dr. A. A. Berg. The gastro-enterological surgical cases are grouped on his division. Inasmuch as I assumed charge of another division last year, I have had no opportunity to add to my material during 1929.

Statistical reports often fail to give a true picture of the mortality rates since the author confines his review of personal cases to recent years. The reader marvels at the remarkably low mortality and gets the impression that the operation described by the author is practically without risk. A more correct picture is obtained, if the author reviews all his cases and shows the higher mortality rates which were encountered until he had standardized his technic.

A complete list of my cases of partial and subtotal gastrectomy for gastro-duodenal ulcers is presented in Table I. Both primary and secondary opera-

tions are included in this survey. In some of the earlier cases operative methods were employed which were soon abandoned, as the results were most unsatisfactory. I have performed sixty-nine partial and subtotal gastrectomies for ulcer. Fifty-six cases were primary operations, thirteen were secondary operations. Sixty cases were operated at Mount Sinai Hospital, nine cases at Beth Israel Hospital. Five cases were operated during or immediately after a profuse hæmorrhage. Among the fifty-one resections for chronic ulcers twenty-three were gastric, three pyloric and twenty-five duodenal ulcers.

Gastro-enterostomy with or without pyloric exclusion was used as the method of choice in the surgical treatment of duodenal ulcers up to 1923.

TABLE II

*Primary operations for chronic gastro-duodenal ulcers*1) *Billroth I:*

1. 1922: S. S.                      2. 1923: J. M.                      3. 1924: M. C.

2) *Finsterer Operation*

1. 1923: E. B.                      2. 1923: L. W. +

3) *Antecolic Billroth II:*

1. 1922: H. M. +                      2. 1923: E. C. +

4) *Retrocolic Billroth II:*


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1. 1920: D. W.	12. J. S.	23. M. S.	34. N. U.
2. H. S.	13. A. K.	24. R. L.	35. 1927: H. T.
3. 1921: M. C.	14. M. A.	25. J. R.	36. C. G.
4. J. F.	15. 1924: J. A.	26. S. G.	37. M. K.
5. 1922: O. S.	16. A. G.	27. L. E.	38. B. W.
6. D. B.	17. N. G.	28. 1926: F. G.	39. J. B.
7. 1923: B. S.	18. D. Z.	29. M. F.	40. 1928: H. S.
8. S. P.	19. G. S.	30. H. L.	41. J. L.
9. A. G.	20. O. L.	31. M. L.	42. A. H.
10. S. T.	21. 1925: M. F.	32. H. L.	43. M. G.
11. L. S.	22. J. L.	33. M. S.	44. J. B. +

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Thus the gastric resections reported during 1920, 1921, and 1922 were performed for gastric ulcers. After Haberer reported his results with resection of the stomach in duodenal ulcers and after a visit to his clinic in Innsbruck, partial gastrectomy was performed, whenever technically feasible, both for gastric and duodenal ulcers.

A perusal of Table II brings out a point of importance. During the first year after the adoption of partial and subtotal gastrectomy for both gastric and duodenal ulcers various procedures were tried in order to determine the best type of gastric resection. Thus during 1923 four different methods (Billroth I, Finsterer Operation, Antecolic and Retrocolic Billroth II) were tested. It soon became evident not only from this comparatively small group, but from the much larger material of Doctor Berg, that at least in our hands the Billroth II yielded the best operative and clinical results. I

have therefore discarded all the other methods and consider the retrocolic Billroth II as the method of choice. Since the standardization of our technic (retrocolic Billroth II) the operative and clinical results have been excellent. Since 1924 nearly all cases were operated according to the Hofmeister technic (a variation of the original retrocolic Billroth II method). In a few instances the anastomosis was performed with the aid of a Murphy button. In very extensive resections for high gastric ulcers near the cardia the Murphy button presents the best procedure for a safe anastomosis.

The only exception to this rule was a Billroth I (Table II, 1) (1924: M.C.) which was operated through a right upper rectus incision for a suspected cholelithiasis. The gall-bladder was found to be normal. The patient was suffering from a duodenal ulcer. With the limited exposure at hand it was deemed advisable to perform a Billroth I.

The Billroth I anastomosis is apt to be comparatively narrow and thus interfere with the proper emptying of the gastric contents into the intestines. In the case just mentioned (M.C.) the obstruction was so marked that I had to perform a gastro-enterostomy seven days after the primary operation. At the secondary operation a large inflammatory tumor was found at the site of the anastomosis.

Furthermore post-operative achlorhydria—a most important factor in the prevention of secondary ulcerations—is more apt to follow the Billroth II anastomosis than the Billroth I. In the Billroth II the line of gastric resection can be much higher than in the Billroth I. A comparatively high dissection of the stomach is of the utmost importance for the establishment of a post-operative achlorhydria.<sup>4</sup>

The Finsterer operation (gastric resection without the removal of the duodenal ulcer) cannot be recommended. It is undoubtedly a major procedure. Yet the duodenal ulcer and sometimes the pylorus are left in situ, thus making possible recurrent symptoms from the old ulcer or a recurrence from an ulceration at the stoma.

I have used the Finsterer operation during 1923 in two primary cases. One patient died on the day following the operation from cardiac failure. The other patient made an uneventful recovery.

In the rare instances in which primary resection of a duodenal ulcer on account of its deep location and on account of the involvement of the common duct would present too great a risk for the patient a simple retrocolic gastro-enterostomy is indicated, rather than the major operation of subtotal gastrectomy without the removal of the ulcer (Finsterer operation).

In secondary operations for gastro-jejunal or jejunal ulcer with a persistent deep duodenal ulcer the Finsterer operation may be a very useful procedure. Resection of the stomach with secondary reduction of the hyperacidity presents the only possible way to prevent a recurrent ulceration at the stoma. Yet the reserve of the patient may have been taxed too severely by the prolonged operation in dealing with the gastro-jejunal ulcer, that it may be advisable to desist from the excision of the duodenal ulcer. One

patient (Table IV, 5) has died following the operation. The other two cases (Table IV, 2 and 4) have been perfectly well (observation time: five years).

Any statistical review of operative results should report those cases in which on account of the deep location of the duodenal ulcer and its marked adhesions to important neighboring organs simple gastro-enterostomy was performed. It is very evident that by reserving partial and subtotal gastrectomy for easily resectable ulcers, the mortality can be kept at a very low figure. It is of great importance that in a statistical report those cases should be mentioned in which on account of location (very high at the cardia or very low near the common duct) simple gastro-enterostomy was performed.

The vast majority of ulcers are resectable, though the operation may offer great technical difficulties. I did not find a non-resectable ulcer until 1927. Since then I was forced in two cases of deep duodenal ulcers to perform a gastro-enterostomy.

The antecolic Billroth II has not been used since 1923. I had used this method in two cases; both patients died from peritonitis. In both cases extensive resections were made and I felt at the time that the anterior anastomosis was preferable. I have since performed even more extensive resections by the retrocolic Billroth II method with perfect success. I feel sure that the post-operative peritonitis would not have occurred if the retrocolic route had been used. An antecolic anastomosis is apt to produce leakage, when the distended colon begins to press on the suture line. I would not use an antecolic anastomosis again, except in those very rare cases in which an anomaly or absence of the mesocolon prevents us from applying the retrocolic anastomosis.<sup>5</sup>

The retrocolic Billroth II method (either in the form of the Hofmeister anastomosis or with the aid of a Murphy button) has given excellent results in my hands. Between 1920 and 1928 forty-four cases were operated by this method with one death (Case No. 44). This patient had a very high gastric resection for an ulcer near the cardia and died eleven days post-operative from peritonitis in the upper abdomen. Post-mortem was not obtained. Thus we had forty-three consecutive cases without a death. I think that any method which gives a mortality rate of 2.27 per cent. can be recommended to the medical profession. In fact the mortality rate following resection of the stomach is slightly lower than the death rate following gastro-enterostomy in the years when gastro-enterostomy was used extensively on the service. Thus in spite of the fact that I have used the major operation of partial and subtotal gastrectomy, the mortality rate was not increased.

I have always felt that the opposition against partial and subtotal gastrectomy really centers around the question of post-operative mortality. Many other arguments have been brought forward in favor of more conservative procedures. Yet I am sure that resection would become very popular, if a low mortality were assured. My experience shows that with the retrocolic Billroth II method the mortality rate for partial and subtotal gastrectomy can be held to a very low level.

I am well aware of the fact that some of the methods which I discarded many years ago are extensively used in other clinics with good results. However, the purpose of this presentation is to give my personal experience with different methods.

This paper deals mainly with operative results in chronic gastro-duodenal ulcers. Therefore I shall only refer very briefly to results in bleeding gastro-

TABLE III  
*Operations for bleeding gastro-duodenal ulcers*

No.	Year	Name	Diagnosis	History	Operation	Result
1	1923	M. M.	Bleeding gastric ulcer	Nov. 14th, admitted to medical service following profuse gastric hæmorrhage. Sent home after two weeks. Dec. 4th: Recurrence of hæmorrhage. Hæmoglobin 54	Dec. 5th: Subtotal gastrectomy (button) operation—local anesthesia.	Died at end of operation when gas was given for closure of abdominal wall. Post-mortem: luetic aortitis; coronary artery sclerosis.
2	1924	A. K.	Bleeding duodenal ulcer	July 1924, exploratory gastrotomy for duodenal ulcer (author). Negative findings. Discharged Aug. 16th. Re-admission Aug. 31st for recurrent symptoms. On day of re-admission profuse hæmorrhage. Hæmoglobin down to 42. Transfusion. Hæmoglobin (pre-operative) 60.	Nov. 5th: partial gastrectomy (Hofmeister).	Cured.
3	1926	B. G.	Bleeding duodenal ulcer	Admitted after profuse hæmorrhage. Hæmoglobin 26 per cent, red blood corpuscles 2,500,000. Hæmoglobin raised by two transfusions to 45.	Partial gastrectomy (Hofmeister).	Cured. Long persistent secondary anemia.
4	1926	J. de G.	Bleeding duodenal ulcer	Long history of epigastric distress. Profuse hæmorrhage five days before admission. Admitted June 2nd. Hæmoglobin twenty-five per cent. Operation July 14th; hæmoglobin at time of operation 37 per cent.	Partial gastrectomy (Hofmeister).	Cured.
5	1926	S. L.	Bleeding duodenal ulcer	1922: treated medically for duodenal ulcer in this hospital. Refused operation. Nov. 22, 1926: re-admitted to medical service. Nov. 23: profuse hæmorrhage. Hæmoglobin 49. Operation: Nov. 26th: Blood pressure before operation: 70/58.	Partial gastrectomy (button).	Died 16 hours after operation

duodenal ulcers and secondary operations for recurrent gastro-duodenal or gastro-jejunal and jejunal ulcers.

These eighteen cases are abstracted in Tables III and IV. Profuse gastric hæmorrhage is a very serious complication of a chronic gastro-duodenal ulcer. We prefer to wait until the patient is restored to normal health. However, some cases require immediate operation. The statement that gastric hæmorrhages are not fatal and cease spontaneously is certainly incorrect.

Two patients died following the operation; one patient succumbed sixteen

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hours later; the other died on the operating table. This death must be considered as an anæsthesia death. The patient who had withstood the operation under local anæsthesia perfectly well died suddenly, when gas-oxygen was administered for closure of the abdominal wall. Post-mortem examination

TABLE IV  
*Secondary operations*

No.	Year	Name	Previous Gastric Operations	Operation	Result
1	1922	M. H.	1918: gastro-enterostomy by another surgeon. 1919: division of adhesions (author).	Billroth I for mal-functioning stoma. Secondary jejunos-tomy.	Died
2	1923	J. W.	1) Gastro-enterostomy. 2) Exploratory laparotomy for bleeding duodenal ulcer; both performed by another surgeon.	Finsterer for bleeding duo-denal and gastro-jejunal ulcers.	Well
3	1923	S. N.	Excision and eauterization of gastric ulcer, performed by another surgeon. Immediate recurrence.	Billroth II (button) for recur-rent gastric ulcer. Four-fifths of stomach removed.	Well
4	1923	A. Z.	1913: gastro-enterostomy (Boston). 1915: appendectomy (Boston). July. 1923: excision gastro-jejunal ulcer. Disconnection stoma (author). Post-operative complication: lung abscess. Recurrence of duodenal ulcer. Dec., 1923: re-operation.	Finsterer for recurrent duo-denal ulcer.	Well
5	1925	J. M.	1918: appendectomy (Post-Graduate Hospital). 1921: gastro-enterostomy (Hartford). 1924: exploratory laparotomy (Hartford).	Finsterer for gastro-jejunal and duodenal ulcer.	Died
6	1925	I. S.	1918: gastro-enterostomy and pyloric exclusion for duodenal ulcer (author).	Billroth II for jejunal ulcer.	Well
7	1926	B. E.	1920: gastro-enterostomy for pre-pyloric ulcer by another surgeon. 1921: re-laparotomy. Division of adhesions by another surgeon.	Billroth II formal-functioning stoma and pre-pyloric ulcer. Secondary cholecys-tostomy for acute chole-cystitis. 1928: cholecystec-tomy for cholelithiasis.	Improved
8	1927	N. D.	1917: gastro-enterostomy and pyloric exclusion for duodenal ulcer by another surgeon. 1925: excision gas-tro-jejunal ulcer. Removal exclusion stitch. Disconnection gastro-enter-ostomy. Entero-enterostomy by the same surgeon.	Billroth II for penetrating duodenal ulcer. Secondary entero-enterostomy.	Died
9	1927	C. L.	1926: gastro-enterostomy for duodenal ulcer (Fordham Hosp.). 1926: ex-cision of gastro-jejunal ulcer. Dis-connection of stoma. Finney pyloro-plasty (Fordham Hospital).	Billroth II for duodenal ulcer.	Died
10	1927	M. G.	1927: suture of perforated pyloric ulcer by another surgeon.	Billroth II for recurrent ulcer.	Well
11	1927	S. G.	1925: excision of duodenal ulcer. Ap-pendectomy (San Diego).	Billroth II (subtotal) for re-current duodenal ulcer.	Died
12	1927	A. G.	1924: antrumectomy for duodenal ulcer (author). 1927: acute perforation of gastro-jejunal ulcer.	Billroth II (subtotal) for per-forated gastro-jejunal ulcer.	Well
13	1927	D. G.	1918: gastro-enterostomy for gastric ulcer by another surgeon.	Billroth II for jejunal ulcer.	Died

tion show extensive luetic aortitis and coronary artery sclerosis. The three cases which survived operation had a hæmoglobin of 37, 45 and 60 per cent. at the time of operation. These cases of profuse hæmorrhage are an indict-ment against prolonged medical treatment and show the risk which these



patients incur. All these patients had a long ulcer history and repeated courses of medical treatment.

Partial and subtotal gastrectomy was the only possible procedure in the attempt to cure these patients. Yet gastric resection in these desperately sick patients must be associated with a high mortality. It is evident that this group of cases offers an entirely different surgical problem from the chronic gastro-duodenal ulcers.

Table IV presents thirteen cases of secondary operations with six deaths. Details of the previous operations are given on this table. Eight cases had two or three previous operations. Five cases were operated for gastro-jejunal or jejunal ulcers, six cases for recurrent gastric or duodenal ulcers and two for mal-functioning stoma. It is a well-known fact that secondary operations, especially those for gastro-jejunal or jejunal ulcers, often present the greatest technical difficulties.

This table shows very well the *marked differences as to operative risks* in primary and secondary operations. It has been stated many times that gastro-enterostomy should be the operation of choice at the time of the primary operation and that resection should be reserved for recurrent ulcers. The good results reported above by the retrocolic Billroth II method in primary resections for chronic gastro-duodenal ulcers and the high mortality following secondary operations present a strong argument in favor of primary partial and subtotal gastrectomy in gastro-duodenal ulcers.

#### CONCLUSIONS

1. The retrocolic Billroth II method is the best procedure for partial and subtotal gastrectomy in chronic gastro-duodenal ulcers. One death occurred among forty-four cases (mortality 2.27 per cent.).

2. Medical treatment should be given only over a limited period.

3. Early operation is advisable in order to prevent serious complications such as perforation and hæmorrhage.

4. In order to reduce the number of secondary operations, which are followed by a high mortality, partial and subtotal gastrectomy should be performed as the primary operation for gastro-duodenal ulcers.

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## CURLING'S ULCER

DUODENAL ULCER FOLLOWING SUPERFICIAL BURNS

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CASE HISTORY.—A white boy of eleven years was admitted to my service at Touro Infirmary August 26, 1929, with superficial first-degree burns from gasoline, which involved both lower extremities from the ankle to the junction of the middle and upper third of the thigh. The previous history was irrelevant. On admission his temperature was  $96.5^{\circ}$  and his pulse 90. The following day they rose respectively to  $100.8^{\circ}$  and 160, and there was evidence of a severe toxæmia, with vomiting of all food, involuntary voiding and extreme delirium. Under local and constitutional treatment there was progressive improvement until September 2, when he complained of generalized abdominal pain, which was somewhat relieved by an enema. Shortly thereafter he vomited blood-stained material, and macroscopic blood was observed in the stools. Blood study at this time showed 3,240,000 red cells, 29,100 leucocytes, and 67 per cent. polymorphonuclears. Urinalysis was essentially negative, the trace of albumin evident on admission having disappeared. The blood-pressure was 100/64; September 3, copious hæmorrhage from the bowel having continued, it fell to 88/0. On that day the abdomen, which had been quite soft, gradually became distended and tender, and tympanites was marked. Transfusion was done and repeated the following day, 250 cubic centimetres of citrated blood being given each time. The first injection resulted in some improvement in the general condition, but shortly after the second the patient became wildly delirious, the bowels moved involuntarily with profuse hæmorrhage, although there was no further vomiting, and death ensued within a few hours.

Autopsy, which was done immediately, was essentially negative except as regards the gastrointestinal tract, the spleen and the kidneys. The latter organs showed acute splenitis and acute glomerulo-nephritis. The jejunum and ileum were both distended, and the ileum was full of blood. A small purplish-brown area, about  $1/2$  centimetre in diameter, was discovered at the junction of the first and second portions of the duodenum, and examination of the mucosal surface showed a small ulcerated area, about  $3/4$  centimetre in diameter, about to perforate, at the outer margin of the descending portion. Another larger but more superficial area, which involved only the mucosa, was evident at the same level in the posterior wall, and was considered to be a contact or "kissing" ulcer.

I am aware of the pitfall of reporting single cases, but I think circumstances such as these justify the act. This boy died from a disease which I knew could exist as a complication of burns, indeed which I had encountered at least once before, but which, because it was unusual, I failed to diagnose, in spite of the definite evidence that gastrointestinal pathology was present. Whether he could have been saved with the proper treatment I cannot say. Perhaps not. But that does not lessen my responsibility, and my failure to identify accurately an unusual but perfectly possible disease is my excuse for presenting this report.

Curling's ulcer is very largely an unknown lesion. If it is mentioned at all in the textbooks the description is of a very cursory character. This is partly due to the fact that it is seldom recognized during life, partly because

its incidence, as I shall point out shortly, is variable and rather low, and chiefly, I think, because it is most frequent in children, whose symptoms are notoriously vague and in whom it is easy to overlook the diagnosis of even more usual conditions.

Curling in 1842 first described duodenal ulcer associated with burns as a clinical entity, though he himself admits that Dupuytren, some ten years before, had called attention to ulceration of the intestines as a late finding in patients who survive the immediate effects of the injury. Curling, however, definitely localized the lesion in the duodenum, though for the sake of historical accuracy we might add that contributions to the subject had been made by Cumin in 1823, by Cooper in 1840 and by Long in the same year, and that Erichsen wrote a comprehensive paper upon it in 1843.

Curling, in the treatise which he read before the Royal Medico-Chirurgical Society, reported ten cases, four of which he had seen personally. The ulceration, as he described it, is of an acute character, the immediate cause of death being perforation with consequent peritonitis in three of his cases and hæmorrhage in six. One patient survived five weeks, the others died in from seven to seventeen days. He also described three other cases, one seen personally, in which post-mortem examination showed a definite increase in vascularity as well as definite inflammation of the duodenum, though there was no destruction of substance. Finally, he described a cicatrized duodenal ulcer from the collection in the Hunterian Museum; this was exhibited in the body of a young woman who had died of exhaustion eight weeks after a burn, and is unquestionably of the same type.

It is nearly a century since Curling established the sequence of burns and duodenal ulcers, yet there is still no uniformity of opinion as to the incidence of the lesion. Erichsen, a year after Curling's identification, found them in two of twenty-eight fatal cases. Ronchesi found them in one of 348. Fenwick states that they are present in 6.2 per cent. of all deaths from burns, while Holmes, in 125 cases, reports an incidence of sixteen, 12.8 per cent. Harris, with an experience of 567 cases and 138 deaths over a twelve-year period, found only one case. Levin, reporting for himself, his predecessor and two of his associates, with fifty composite years of service at Johannesburg, and with an experience of fully 12,000 autopsies, found only two cases, and those when he had begun to believe that the lesion was merely a medical myth. Bancroft and Rogers found none in 104 cases, and likewise seem doubtful of the existence of the disease. The indices of the New Orleans Charity Hospital show not a single instance, although this institution has probably the largest accident service in the South. The case I have reported is the only one recorded at Touro Infirmary. Are these ulcers decreasing in incidence, or are we simply failing to find them because we do not look for them? My own experience inclines me to the latter view.

Such ulcers are commonest in children, the average age in Curling's series being 10.8, and all but two of his patients being under 15. They are usually considered a late complication, but as a matter of fact, and as the literature

evidences from the beginning, they may occur at any time.' Levin mentions Parfick's case, quoted in Choyce's *System of Surgery*, in which the ulcer was evident eighteen hours after injury, and in Harris's case death ensued on the third day, perforation, as the autopsy showed, having already occurred. In many instances, however, the lesion develops during the third or fourth week of illness, when the patient has apparently recovered from the critical stage of the injury. In Simpson's case the intestinal symptoms developed at the end of one hundred days, when the local condition was progressing to recovery. In spite of the epigastric pain, I am doubtful whether this patient really had a duodenal ulcer, though the intestinal ulceration is beyond question.

The symptoms, as Curling names them, include pain and tenderness to pressure on the right side, midway between the cartilage of the ribs and the umbilicus, uneasy digestion and vomiting. When ulceration ensues, the stools are dark and bloody. In very acute instances, either hæmorrhage or perforation may be the initial sign, and there may be no symptoms at all, as in one of Levin's cases, in which death was definitely due to pneumonia, and in which, in spite of a complete lack of ante-mortem symptoms, the autopsy disclosed a typical ulcer which had evidently just perforated. In short, the symptomatology and clinical course are akin to those of the ordinary chronic or acute peptic ulcer. Curling is quite correct when he points out that the morbid action, however acute it may be, is deep-seated and limited in extent, as well as masked by the general derangement. The pathology of the burn itself—which is the pathology we look for and expect—dominates the clinical picture, and again I revert to my thesis, that only by bearing in mind the possibility of the unusual complication can we be certain of not overlooking it.

The etiology of Curling's ulcer, as is the case with other peptic ulcers, is still an unsolved problem. The burn, of course, introduces certain special considerations, for in addition to the local pathology there are inevitable systemic and constitutional complications. Severe burns are characterized primarily by pain and shock. Following these there is evident a profound toxæmia, decidedly more marked in children, which, by its effect on the central nervous system, may result in hyperpyrexia, vomiting, drowsiness and convulsions. Finally, there may be exhibited such complications as pneumonia, nephritis, or the protean manifestations of infection, the latter being especially evident in improperly treated cases.

Curling's theory of the etiology of these ulcers, considering the limited medical knowledge of the day, is rather an ingenious one. Congestion of the mucous membrane, he says, is an insufficient explanation, because the remainder of the alimentary tract, although participating equally in the vascular disturbance, rarely becomes affected. The glands of Brunner, however, he found enlarged and infiltrated in at least one fatal case, and his idea was that the sudden arrest of the important functions of the skin rouses in these glands an endeavor, by increased action, to compensate for the suppression of dermal exhalation, the irritation from hyperactivity leading eventually to inflamma-

tion and ulceration. The specific localization is thus explained, and the hæmorrhagic feature is due to the fact that if perforation does occur, the *arteria pancreatica-duodenalis*, because of its position, necessarily becomes exposed. This theory he considered confirmed by the fact that the disease, if not fatal, goes on to recovery when the functions of the skin are reëstablished, though he apparently failed to see that it does not explain the fairly frequent cases in which the ulcer does not exhibit itself until the local condition is progressing toward recovery.

In more modern days Cooke and Falk have advanced as a cause a reflex inhibition of the intestinal circulation, Falk adding that the depressed action of the heart or the impaired nourishment of the mucous membrane is a predisposing factor. Billroth and Moynihan consider it an embolic process, Moynihan pointing out that the ulcer never occurs without septic changes in the burn. Simpson and others consider it due to a sort of ante-mortem digestion, that part of the mucous membrane being affected in which the circulation has been arrested by congestion or embolism.

The consensus of modern opinion regards the toxæmia of burns rather than the circulatory disturbance as responsible for the production of the associated duodenal ulcers. Certainly, since the toxæmia is most marked in children, this would explain their most frequent incidence in young subjects. According to Hunter, a toxic substance is elaborated in the burned tissues and excreted in the bile, and he was able to produce such ulcers experimentally in dogs by the injection of toluylenediamin. Fenwick, on the other hand, could not produce them by tying the common duct, and Busse produced general intestinal as well as duodenal ulceration and hæmorrhage by the injection of extracts elaborated from the burned areas of the skin. DaCosta is opposed to Hunter's theory on the ground that the typical ulcer occurs well above the ampulla of Vater. Catiano and Harris advance rather similar theories, to the effect that the action of the toxin, by reducing the natural alkalinity of the intestinal wall, causes focal necrosis and hæmorrhage, the areas being transformed into ulcers by the action of the pancreatic juice. Levin's theory is along the same lines. He believes that the shock incident to all burns causes either a true or a relative hyperacidity and hypoalkalinity, that the special toxin of burns is a substance which may be akin to histamine, and that the combination of hyperacidity and the devitalizing effect of the toxin on the mucous membrane favors the development of the ulcer. The specific localization he explains, as all duodenal ulcers may be at least partially explained, by the tortuosity of the vessels of the lesser curvature of the stomach and the first part of the duodenum, their relatively poor anastomosis rendering them more liable to thrombosis. This, of course, is in keeping with the well-known demonstration of Wilkie, amply corroborated by Finney, of the rôle played by the superior duodenal vein in most peptic ulcers involving the first portion of the duodenum.

All theories fail, I might remark, to explain the case reported by Leonard and Dayton. Post-mortem examination of a patient with cervical carcinoma

who had been treated by the Percy method revealed a typical Curling ulcer. Since the skin factor is entirely lacking here, no explanation yet advanced fits the case.

It has long been recognized that while these ulcers might exist anywhere in the intestinal tract, they were most common in the first portion of the duodenum, but it remained for Pack, in 1926, to describe the histopathology definitely. They may vary in size, he says, from a pinhead to a quarter, and the amount of tissue loss depends on whether the lesion is a mere erosion or a rapidly sloughing perforative process. The ulcer is frequently funnel-shaped, due to loss of more mucous membrane than muscle tissue, and the shape may be irregular and dentate, long and narrow, or, less often, circular. The edges are sharply and cleanly cut, and the base is clean and grayish, though, in the rare instances in which the lesions tend to chronicity, the edges may be indurated and there may be some inflammatory reaction about the margin. Lymph and fibrinous exudation may be seen on the peritoneal surface, as a pre-formed and protective barrier to the lethal progress of the disease if perforation threatens. The factor of time may exert some influence on the depth of penetration, but the age cannot be accurately estimated from this, since the lesion is so insidious and so asymptomatic in its incipency as to elude diagnosis. The outcome is perforation, hæmorrhage or spontaneous healing.

As a remote result of a healed duodenal ulcer of the Curling type, I quote the following case: Early in my practice I treated a white male, then aged forty-eight years, for extensive burns of the chest, epigastric region and both legs, the recovery being complicated by lobar pneumonia, and by definite symptoms of a duodenal ulcer. At the age of sixty-five he consulted me again, complaining of various digestive disturbances which rather suggested gall-bladder pathology, though in view of his age malignancy had to be considered. He refused operation. Three years later, at sixty-eight years, he returned again, this time with a history of recent acute digestive symptoms, constant epigastric pain, very marked loss of weight, in short, the whole symptom complex of gastric malignancy. Exploratory incision revealed inoperable carcinoma of the upper abdomen, with extensive retroperitoneal metastases. There was definite pyloric infiltration. Nothing could be done for his relief, and he died of inanition two weeks later. There is little doubt in my mind that in this instance the carcinoma was superimposed upon the old cicatrix, and the chain of events raises the question of whether the Curling variety of ulcer, unlike the usual duodenal ulcer, predisposes to malignancy.

In no case of Curling's ulcer reported in the literature, so far as I can ascertain, was the specific lesion treated. It was either revealed at post-mortem, there being no suspicion of its previous existence, or the patient recovered spontaneously. But such therapeutic nihilism is obviously without justification. Curling stated in his paper that in any case which in the future he should recognize during life, he would apply leeches to the skin

of the corresponding part of the abdomen, and would give mercury and chalk, with opium for pain, and bland fluid nourishment. We have no record of whether the treatment he outlined was ever applied, and in any event it is not a regimen suitable today for any sort of ulcer. For my own part, in another case of bleeding ulcer such as I have reported, I shall be tempted to resort to surgery, as I should resort to it for other bleeding peptic ulcers. Transfusion availed nothing, and surgery, even though the boy was a frankly poor risk, might have saved his life. In the non-acute type of ulcer, prophylactic excision might be justified, even in seriously burned patients, where the risk would be very high, to avoid the possibilities—which are not remote—of perforation or hæmorrhage. The exact procedure, however, is beside the point. My premise is that something should be done. There is no justification, in this epoch of medical achievement, for permitting patients to die from a disease in which, if it were promptly diagnosticated and properly treated, they might have at least a chance of life.

#### SUMMARY

1. Ulcer of the duodenum, described in 1842 by Curling as a complication of burns, has an estimated incidence in fatal cases of 6 per cent. or more, and occurs most frequently in young children.

2. Its symptomatology and clinical course do not differ from those of the ordinary peptic ulcer, but its existence is prone to be overlooked in the severe constitutional and systemic manifestations which follow burns.

3. The etiology is still unsettled, but the theory of a toxæmic origin seems more reasonable than the theory of a circulatory origin.

4. The histopathology has recently been comprehensively described by Pack.

5. The literature contains no treatment for this type of ulcer, and it is suggested that at least in some cases surgery, as applied to the ordinary peptic ulcer, would seem to warrant a trial.

6. Two additional cases are reported, one in a boy, with fatal result, the other in a patient who recovered and who, twenty years later, died of carcinoma, probably superimposed upon the site of his original ulcer.

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# DUODENITIS AND DUODENAL ULCER\*

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IN MANY cases of duodenal ulcer, in which clinical symptoms and röntgenograms are indicative of ulcer, a definite lesion cannot be found; instead there is a more or less localized thickening of the wall of the duodenum even with some stippling and scarring of the serosa. It is my purpose to describe the excised material and to demonstrate the entity, duodenitis, and its possible relationship to duodenal ulcer.

My observation is based on more than 200 excised specimens from which frozen sections were made; the fresh sections were stained with polychrome methylene blue and the formalin-fixed sections were stained with hæmatoxylin and eosin. The excised tissue was all from the first portion of the



FIG. 1.—Duodenitis (x 75).



FIG. 2.—Chronic duodenitis (x 25).

duodenum and varied from slight thickening of the duodenum to a typical perforating type of ulcer. In some instances the lesions were multiple. Age, sex, and length of history varied and the clinical<sup>16</sup> and röntgenographic<sup>5</sup> data always leaned toward the diagnosis of ulcer.

By the term ulcer is usually meant dissolution or a break in the continuity of tissue, with a crater of variable depth and shape which is composed of fibrous and inflammatory tissue extending to the submucosa, muscularis propria, and serosa. Irregular shallow areas of dissolution involving the mucosa, or the mucosa and muscularis mucosæ are usually spoken of as erosions and ulcerations. Erosions especially are characterized by absence of fibrosis in the base and margins. The histologic picture of a chronic duodenal ulcer is similar to that of chronic gastric ulcer.<sup>19</sup>

Much has been written on the etiology of peptic ulcer. The older pathol-

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ogists stressed the idea of infarcts and thrombosis which no doubt were found occasionally in specimens at necropsy and were usually chronic. In the literature and in most textbooks acute ulcers of the stomach and duodenum receive little attention and are sometimes completely ignored. Cruveilhier<sup>2</sup> initiated the idea that a chronic ulcer arises from an acute variety, the beginning lesion being inflammation of a solitary follicle with its subsequent rupture and circumscribed area of inflammation with necrosis and hæmorrhagic erosion. Virchow<sup>18</sup> originated the idea that spasm of the muscular coats of the stomach or portal stasis might cause hæmorrhagic infiltration into the mucous membrane, with resulting ulcers. These minute extravasations might be caused by vascular spasm, congestion, or bacterial infection.

Inflammation of the duodenum with and without erosion may be caused by a single factor or a combination of factors, as trauma from within and without, high temperature (heat), strong acids or alkalis, vascular disease, emboli, functional disturbances and allergic reactions.<sup>9</sup> Inflammation and ulcer of the duodenum have been produced experimentally by many workers in various ways.<sup>12, 14, 17</sup> Stasis may play an important part in the production of lesions of the duodenum and may be brought about by periduodenitis, the shape and angulations of the duodenum, compression, or duodenal atony. Stasis of the chyme causes irritation of the mucosa and furnishes an excellent culture medium for the development of any existing organisms.<sup>15</sup> Normal bile can disinfect the duodenal contents and likewise infected bile can infect it and at the same time cause a change in the reaction of the chyme. This may explain the frequent association of duodenal ulcer in biliary disease and biliary lithiasis. The part that heredity and constitutional make-up play must not be overlooked for ulcers are often seen in certain families and in certain types of persons.

The relationship of duodenitis and gastritis to duodenal ulcer and gastric ulcer has been rather thoroughly considered by Hauser,<sup>3</sup> Konjetzny,<sup>6</sup> and Konjetzny and Puhl.<sup>7, 8</sup> Konjetzny, and Konjetzny and Puhl based their arguments on observations on freshly resected material. The many clinical, pathologic, and experimental studies from the time of Virchow to the present were thoroughly considered by these authors, but they did not reach any definite or convincing conclusions. However, Konjetzny and Puhl contended that inflammatory erosions are the forerunners of ulcers in the duodenum and stomach.

Inflammation of the duodenal wall may be localized to the mucosa or it may involve all of its coats. In mild cases the mucosa is infiltrated with a few lymphocytes, an occasional polymorphonuclear leucocyte and some congestion of the capillaries. There is some hyperplasia of Brunner's glands and in some instances slight thickening with diffuse fibrosis of the muscularis propria. Brunner's glands normally exist in the duodenum above and below the muscularis mucosæ, sometimes occupying the entire submucosa, and are more numerous in the first portion. In more advanced cases the mucosa contains a larger number of polymorphonuclear leucocytes, collections of

lymphocytes, some plasma cells and eosinophiles. In some cases there are one or more small erosions in the mucosa producing a ragged appearance with adherent mucus and débris. This more acute or subacute inflammatory process is usually confined to the mucosa and submucosa. The submucosa is oedematous and contains lymphocytes and a few mast cells. The glands of the duodenum show activity in the presence of inflammation by the occurrence of numerous regenerative cells and mitotic figures. The muscularis is intact but is infiltrated with lymphocytes and a variable amount of fibrous connective tissue. The serosa is usually only slightly thickened. Brunner's glands are distinctly more numerous and in the less acute lesions lie among intervening fibrous connective tissue. Throughout all layers may be seen small collections of lymphocytes without any germinal centre. Blood-vessels are moderately sclerosed but not obliterated. In the more chronic forms there is more fibrous tissue throughout, fewer polymorphonuclear leucocytes



FIG. 3.—Healed duodenitis (x 25).



FIG. 4.—Healed duodenal ulcer with heterotopic gland in scar (x 25).

in the mucosa, with definite germinal centres, less glandular epithelial activity and more interlobular fibrosis among Brunner's glands. Occasionally there is dilatation of both types of glands. In some of these chronic forms of duodenitis or ulcerated duodenitis the gross section looks like an ulcer but on closer examination there is a moth-eaten appearance instead of a regular punched-out crater. W. J. Mayo<sup>13</sup> noted this difference in the ulcers he excised from the anterior wall as compared to those in the posterior wall and in the stomach.

In chronic duodenitis there is no distortion of the musculature and the mucosa contains lymphocytes, plasma cells, and eosinophiles. Large collections of lymphocytes and germinal centres are also present. Brunner's glands are distinctly increased in number, with definite interlobular fibrosis. This may grossly simulate a scar of a healed ulcer.

In many cases healed ulcerative duodenitis closely resembles a small healed ulcer. There is marked hyperplasia of Brunner's glands on each side of a scarred area in the mucosa and submucosa without distortion or extensive involvement of the muscularis propria. In this area are mucosal glands and

Brunner's glands, infiltrated with lymphocytes. In the ulcer there are no glands and the surface is covered by a single layer of epithelium. The muscularis is more involved and slightly cocked owing to the separation of the muscularis and its blending with the submucosa and muscularis mucosæ. In both conditions the mucosa and also the other layers contain a variable number of large germinal centres. The blood-vessels are sclerosed and sometimes nearly obliterated. The serosa is variable in thickness.

The typical true duodenal ulcer is similar to the gastric ulcer. The crater is composed of dense fibrous tissue, the muscularis being completely retracted and blended upward with that of the submucosa and muscularis mucosæ. Nearer the surface is granulation tissue consisting of young connective tissue with well-formed small blood-vessels, and on the surface débris, mucus, lymphocytes, polymorphonuclear leucocytes and bacteria. The shape, size and depth of the crater varies. On either side the submucosa is thickened, œdematous or completely obliterated. There is a distinct increase in number of Brunner's glands with fibrosis between the lobules. If the ulcer is in the pyloric ring this will be noted on the duodenal side only. Throughout all the coats are lymphocytes, both scattered and in collections, with oftentimes a germinal centre. In the mucosa are found also plasma cells, eosinophiles and a few polymorphonuclear leucocytes. In the less chronic conditions there is much activity of the glandular epithelium, as evidenced by the presence of regenerative cells and many mitotic figures.

Duodenal lesions are most common in the first portion of the duodenum. Sometimes on exploration stippling and scarring of the serosa is not found but on opening the duodenum dimpling, ulceration or thickening is noted. There may be multiple lesions, one or more of which have a typical crater. Such observations would suggest generalized disease of the duodenum and would also indicate that all lesions should be treated. Duodenitis and duodenal ulcer may not always be local because of their frequent association with pathologic conditions elsewhere in the body.

In the specimens studied I have observed in only one case, that of duodenitis with erosion, an infarct or recent thrombus. In the base was a small vessel recently thrombosed, which may have been an infarct causing the ulceration. In a few specimens, minute follicular ulcers were present which evidently were due to the explosion of an inflammatory hyperplastic solitary lymph node. I have noted similar microscopic ulcerations in appendices which were acutely or subacutely inflamed.

There seems to be some relationship between duodenitis or inflammation of the duodenal wall and the true typical duodenal ulcer.<sup>11</sup> In the moderately thickened duodenal wall the mucosa is infiltrated with lymphocytes, plasma cells and polymorphonuclear leucocytes, with congestion of the capillaries and even with some extravasation into the delicate stroma, thereby producing minute hæmorrhagic erosions. The glandular epithelium may show some activity by the presence of a larger number of regenerative cells and a few mitotic figures. The submucosa is usually œdematous, and Brunner's glands

are increased in number, both above and below the intact muscularis mucosæ, without any cellular changes. The muscularis propria may be lightly and diffusely infiltrated with lymphocytes and fibrous connective tissue. The serosa is usually not involved. In more advanced cases there is greater cellular activity and fibrous connective tissue replacement. Certainly in inflammation anywhere in the body there is accompanying degeneration and necrosis of some of the affected area and it would appear that the same condition could exist in the duodenum with or without the definite formation of an ulcer. In the more chronic forms there are numerous large germinal centres in all layers, including the serosa. This is also seen in sections of duodenal ulcers. The muscularis is usually not cocked as it is in the ulcer; in the ulcer the cocked appearance is due to loss of tissue balance which results in blending of muscularis with muscularis mucosæ and the submucosa, and occasionally it is an artifact due to the fixation. In all types and conditions of duodenitis there is distinct hyperplasia of Brunner's glands with a variable amount of intervening fibrosis in the more chronic and healed types. Cellular changes have not been noted in Brunner's glands and their hyperplasia may be compensatory in an attempt at neutralization or the performance of some other function in the duodenal contents.



FIG. 5.—Chronic duodenal ulcer (x 6)

In the true ulcer there are tissue reactions similar to those present in duodenitis. There is much glandular activity evidenced by the presence of numerous regenerative cells and mitotic figures. Neither in duodenitis nor in ulcer have I observed the cellular changes known as secondary cytoplasmia which MacCarty<sup>10</sup> described as occurring in certain gastric ulcers. In the mucosa are polymorphonuclear leucocytes, lymphocytes, plasma cells, and eosinophiles. These cellular changes are also found in sections taken from the immediate neighborhood of the ulcer. On gross examination, the newly excised lesion appears inflammatory with or without ulceration. This has been frequently noted by Judd.<sup>4</sup> In one section the inflammatory changes were greater on the serosal side, suggesting that the process began as periduodenitis.

The thickness of the walls of the blood-vessels varies in both duodenitis and ulcer, increasing with the chronicity, particularly in the ulcers. In many instances the vessels in the submucosa, crater, and serosa are completely or partially obliterated. Lymphocytic infiltration is present in the media and adventitia, with proliferation of the intima. This proliferation of the intima causes thrombosis with resulting organization and canalization. These vascular changes may be a part of the inflammatory reaction in the tissue and

probably play a part in the chronicity of ulcers. The changes in many respects simulate those described in thrombo-angiitis obliterans.<sup>1</sup> Fibrosis of the myelin sheaths of the nerves has also been noted.

## SUMMARY

Some cases which are diagnosed duodenal ulcer, at operation, show an area of localized thickening of the duodenal wall instead of a definite ulcer. This thickened area is designated duodenitis, which is described as occurring in various forms, as simple duodenitis, duodenitis with erosion or ulceration, chronic duodenitis and healed ulcerated duodenitis. In the more acute conditions there are lymphocytes, polymorphonuclear leucocytes, plasma cells and a few eosinophiles with congestion of the capillaries in the mucosa. In more advanced chronic conditions this inflammatory reaction manifests itself by distinct hyperplasia of Brunner's glands with infiltration of scattered lymphocytes and collections of lymphocytes throughout. The muscularis propria also contains some fibrous connective tissue. The blood-vessels are sclerosed, the sclerosis increasing with the chronicity of the condition. Similar changes occur in the process of development of an ulcer, suggesting a definite relationship between duodenitis and duodenal ulcer.

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# PRIMARY SOLITARY DIVERTICULITIS OF CÆCUM

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THE subject of diverticulitis was first given prominence by Grasser in 1898, at which time it was known as "Grasser's Tumor." The cases studied by him and by Beer, Fisher, Mayo, and others, involved almost exclusively the sigmoid colon; so that even today "diverticulitis", to the average surgeon, means inflammation in the multiple, acquired or "false" diverticula of the sigmoid.

Telling, in 1908, correlated all the existent knowledge on diverticulitis and classified diverticula as either:

1. Congenital, or "true"—such as Meckel's Diverticulum. (All three coats present.)
2. Acquired, or "false"—such as occurs in the typical case of Sigmoid Diverticulitis. (Only serosa and mucosa present—muscularis absent.)

Telling considered these "false" diverticula as simple hernial protrusions of mucosa, submucosa and serosa (note the absence of the muscular layer) through some weakened area of the bowel wall. Klebbs associated these "weakened areas" with the blood-vessels perforating the circular muscle fibres of the bowel wall and Drummond felt that such blood-vessels predisposed to diverticula just as the spermatic cord predisposes to an inguinal hernia. Other predisposing causes universally acknowledged are obesity, constipation, and increased intra-intestinal pressure from whatever cause.

Drummond insists that all diverticula are "false" (*i.e.*, acquired) and always multiple, with the singular exception of a Meckel's diverticulum. In a recent article on diverticulitis of the cæcum, Greensfelder and Hiller likewise insisted that all such diverticula are "false," whether they occur as a primary condition (due to predisposing causes mentioned above) or whether they occur secondarily to trauma, as in a previous appendectomy; they reported four cases of secondary or post-traumatic solitary diverticula of the cæcum.

Other authorities likewise are insistent that all diverticula (save a Meckel's) are acquired or "false" and represent simple hernial protrusions. I, therefore, wish to report a case I recently operated upon; first, because it is very rare, being a case of inflammation in a solitary diverticulum of the cæcum; but also because histological examination of the removed solitary diverticulum demonstrated the presence of circular muscle fibres in part of its wall, a fact which at least suggests the possibility of its congenital origin. A careful review of the literature reveals only one similar case where circular

muscle fibres were present.<sup>7</sup> In this case, reported by Pereira, all three coats were completely present. I am unable to explain, on an embryological basis, the occurrence of a possibly congenital diverticulum of the cæcum, unless it be true as was recently suggested by Greensfelder and Hiller that such primary solitary cæcal diverticulæ may be due to "the retention in some residual form of the appendix which appears early in embryological life but normally disappears before the true appendix develops."<sup>4</sup>

The report of my case follows: Mrs. M. R., sixty-three years of age, white, record No. 31647, was admitted August 7, 1928, on account of pain in right lower quadrant of abdomen, and discharged August 22, 1928. Her family history was negative. Personally, she had suffered from chronic interstitial nephritis, arterio-sclerosis, and hypertension for several years past, and arthritis deformans, involving principally both knees, for past two years. Menopause ten years ago.

The present illness arose suddenly with localized pain over McBurney's point; no preceding generalized abdominal pain. Then followed nausea, but no vomiting. Her fever was 99° F.; this was her first attack.

Physical examination was essentially negative except for abdomen which was tender over McBurney's point and with only a slight amount of localized rigidity present. The pre-operative diagnosis was acute appendicitis, for which operation was done. The appendix was found normal. An inflamed, solitary diverticulum was found adherent to the anterior wall of the cæcum. After separation from surrounding adhesions it was found that the diverticulum arose from the antero-lateral wall of the cæcum, about two inches above the ileocæcal valve. It was about one and a half inches long, tense and congested and contained a large coprolith. The diverticulum was removed and the stump inverted with purse-string. The normal appendix was likewise removed. Uneventful convalescence.

*Laboratory findings.*—Urinalysis—negative. Wassermann blood count 9500—(pre-operative).

*Pathological specimen report.*—1. Normal appendix. 2. Inflamed diverticulum of intestine. This diverticulum is lined throughout with mucosa and contains numerous Lieberkühn glands. The muscularis mucosæ is everywhere present. Surrounding this are a few solitary lymph follicles and fatty tissue. A large patch of circular muscle fibres is also present although it does not completely surround the diverticulum in this particular cross-section. The serosa completely covers the whole diverticulum and all of the layers are moderately infiltrated with lymphocytes, plasma cells, and eosinophilic leucocytes.

Table I shows a tabulation of the essential features in all cases of primary solitary cæcal diverticulitis reported to date, including the above case—eight cases in all. The post-traumatic cases of solitary cæcal diverticulitis reported by Greensfelder and Hiller, Bunts and others, are secondary (not primary) and, hence, not included in this table.

#### SUMMARY

A rare case of primary solitary diverticulitis of the cæcum is reported. Rarer still, histological examination demonstrated the presence of a mass of circular muscle fibres in its wall, a condition which would seem to suggest the possibility of its congenital origin, and the theory that, if congenital, it represents a rudimentary appendix is considered plausible. It would seem



TABLE I

Reported by	Sex	Age	Initial symptom	Subsequent symptoms	Palpable mass	Other physical signs	Size of diverticulum	Copro-lith	Operative procedure	Outcome	Previous history	Pre-op. diagnosis	Microscopic examination of diverticulum
Jackson, 1917	F.	23	Pain in R. L. Q.	Fever, nausea, vomiting	Present	Tenderness, rigidity	2½ x 3 in. on antero-lateral aspect of caecum	Present	Partial resection of caecum	Recovery	.....	Acute appendicitis	Not noted
Pereira, 1927	F.	54	Vomiting	Pain in R. L. Q., slight fever	Present	Tenderness, rigidity	½ in. long, 1 in. from orifice of appendix	Present	Excision of caecum and of part of ileum	Recovery	.....	Acute appendicitis	All three coats present
Moschowitz, 1918	M.	44	Pain in R. L. Q.	None	Present	Tenderness, localized rigidity	1 in. long	Present	Excision of diverticulum	Post-op. pneumonia, then recovery	.....	Acute appendicitis	"False diverticulum"
Cooke, 1922	M.	53	Lower abdominal pain	Fever	Present	Tenderness, rigidity	1 in. long	Present, 2 cm. in diameter	Total excision of caecum	Recovery	Always constipated	Acute appendicitis	Not noted
French, 1923	F.	29	Nausea	Loss of weight	None	Slight tenderness	¾ in. in diameter	Present, "very hard"	Dislodged caprolith and diverticulum inverted and buried	Recovery	Numerous similar previous attacks	Chronic appendicitis	Not done
French, 1923	F.	62	Pain in R. L. Q.	Vomiting, fever	None	Tenderness, rigidity	Not noted	Present, size of a grape	Excision of caecum	Recovery	.....	Acute appendicitis	Not noted
Potter, 1912	F.	32	Abdominal pain	Vomiting, diarrhoea	Present	Rigidity	Not stated	None	Diverticulectomy, appendectomy	Recovery	.....	Acute appendicitis	Not noted
Leonardo, 1929	F.	63	Pain in R. L. Q.	Nausea, slight fever	None	Tenderness, slight rigidity	1½ in. long, 2 in. above valve, on antero-lateral surface of caecum	Present	Diverticulectomy, appendectomy	Recovery	.....	Acute appendicitis	Circular muscle fibres present

that the standard classification of diverticulæ as being "false" or acquired, except a Meckel's, may not be entirely true.

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# THE INTRA-ABDOMINAL POST-OPERATIVE COMPLICATIONS OF APPENDICITIS\*

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THE intra-abdominal complications of appendicitis usually follow acute inflammatory lesions of the appendix, and are prone to occur in those cases in which the infection has extended beyond the appendix. Although any extension of the infection beyond the appendix is a complication, it will be

TABLE I  
APPENDICITIS ON ADMISSION

*Compilation of cases of appendicitis showing incidence of abscess and peritonitis upon admission to the hospital*

Author	Total Cases	Chronic	Acute	Abscess	Abscess Per Cent.	Peritonitis	Peritonitis Percentage	Number Extending Beyond Append.	Percentage
Guerry	2,959	1,607	1,352	517	42	85	6.3	602	48.3
Dudley						48 Diffuse	8.6		
Schaer	2,591	826	1,765	165	9 of acute	238 Beginning	13 Acute	475	26
Stillman	1,748	833	915	258	28	72 Diffuse	46 Acute		
						110 Local	12	411	45
						43 Diffuse	7.9		
Quain and Waldschmidt			1,000	289	29	160	16	449	44.9
Bancroft			534	133	23	73	12	206	35
Clairmont and Meyer	1,594	415	1,179	62	5.2	172 Perforated Appendix	14.6	315	26.6
Cutler <sup>1</sup>			974	290	29	81 Peritonitis	6.9		
						102 General Peritonitis	10	392	39
Gatch and Durman			262					202 "Pus Cases"	78.2
Beekman <sup>2</sup>			145	53	36.4	44	30.4	87	66
Maes			88 (Over 40 years)			18 Ruptured		40	46
	1,000	363	637	431	67	22 Gangrenous	6.2	631	100
Lett						40 Local	26		
						166 General	58		
	1,000	302	698	211	30	401 Local	11	698	100
Charity Hospital Cases			193	57	29.5	80 General	11.9	152	78.7
						23 Diffuse	37.3		
						72 (122)			

<sup>1</sup> Cutler had 392 cases (40 per cent. in which the appendicitis was "Suppurative", requiring drainage.

<sup>2</sup> Beekman's series comprised only children. In all cases under six years of age the appendix was perforated.

<sup>3</sup> These cases showed sufficient evidence of peritoneal involvement to require drainage.

the purpose in this discussion to consider the post-operative complications. The incidence of complications following appendicitis depends upon the extent of the infection at the time the patient is seen by the surgeon. It varies with (1) the age of the patient, (2) the care received previously and the treatment instituted by the surgeon, (3) the virulence of the offending organism, and (4) the resistance of the patient. The extension of the process beyond the

\* Read before the Texas Surgical Society, February 26, 1929.

appendix depends largely upon the care which the patient has received before being brought to the surgeon (especially as regards the administration of cathartics) and the length of time which has elapsed since the onset of symptoms. The extent of the infection at the time the patient consults the surgeon varies in different clinics (Table I). In from 26 per cent. to 100 per cent. of cases of acute appendicitis the infection has extended beyond the appendix at the time of the patient's admission to the hospital. Of 193 consecutive cases of acute appendicitis admitted to the Charity Hospital in New Orleans during a period of 22 months, 67 (29.5 per cent.) presented a localized abscess, 23 (11.9 per cent.) a diffuse peritonitis, and 72 (37.3 per cent.) sufficient evidence of peritoneal involvement to require drainage.

TABLE II  
PERITONITIS

*Compilation of cases of peritonitis occurring post-operatively in appendicitis, demonstrating the percentage of deaths in appendicitis as the result of peritonitis*

Author	Cases Acute Appendicitis	Deaths	Mortality Percentage	Localized Peritonitis	Per Cent. of Mortality	Diffuse Peritonitis	Per Cent. of Mortality
Garlock.....	755	47	6	5	10.6	33	70.2
Beekman.....	145	11	7.6			8	73
Schaer <sup>1</sup> .....	1,290	73	5.7			32	43
Gatch and Durman.....	262	19	7			11	56
Truesdale.....	259	10	3.8			4	40
Cutler <sup>2</sup> .....	974	41	4			31	75
Clairmont and Meyer.....	1,594	49	3			38	77.5
Stillman.....	865	46	5.4			3	6.5
Charity Hospital Series.....	193	39	20.21			23	58

<sup>1</sup> Schaer—of 9 deaths occurring in acute appendicitis, non-perforated, of 13 in appendiceal abscess, of 10 in beginning peritonitis, and of 41 in diffuse peritonitis, the death was due to peritonitis in 2, 5, 4, and 21 instances respectively.

<sup>2</sup> Three hundred and ninety-two cases were of the suppurative type requiring drainage. Peritonitis represented 63 per cent. of all complications.

One must agree with Deaver that severe acute appendicitis always causes a certain degree of peritonitis. It is, however, essential to differentiate, as well as possible, between those types of peritonitis in which the peritoneum of the appendix alone is involved and those in which the infection has extended beyond this viscus. Of the various intra-abdominal complications following appendectomy, the most important, when considering the probable mortality, is diffuse peritonitis. It is rather difficult, from a study of the literature, to determine the incidence of general peritonitis as a post-operative complication, but fortunately this complication is relatively rare. It is, however, responsible for the greatest number of deaths in acute appendicitis (Table II). As a cause of death in appendicitis peritonitis varies from 6.5 per cent. to 77.5 per cent. That a diffuse peritonitis, occurring as a post-operative complication in acute appendicitis, may be the result of improper surgical treatment must not be forgotten. The proper use of the conservative therapy, as outlined by the late Dr. A. J. Ochsner, in selected cases of acute

appendicitis will not only decrease the incidence of diffuse peritonitis as a post-operative complication but will also lower the mortality in these cases.

Guerry, in a series of 123 cases of acute diffuse peritonitis, in which operation was deferred, had a mortality of 1.6 per cent. In another group of acute diffuse peritonitis, which were operated upon immediately, there were 7 deaths (8.2 per cent. mortality). Guerry states, "I am more firmly established today than ever before in the belief that the secret of the mortality lies in the deferred operation as applicable to this particular group of cases." Deaver and Magoun, in a review of 4,588 appendectomies, believe that a decrease in the mortality rate from 10.5 per cent. for the years 1901 to 1905, inclusive, to 4.2 per cent. for the years 1915 to 1919, inclusive, was due to the institution of "conservative treatment" in the proper cases. It is not within the realms of this paper to discuss the operative or pre-operative care of cases of appendicitis. The "conservative treatment," however, is mentioned because of its importance in preventing certain post-operative complications. We wish merely to emphasize, in passing, that the "conservative treatment" is not a medical treatment, but is surgical in every sense of the word. It is one which is extremely difficult to employ properly and one which requires a great deal more surgical judgment than the so-called "radical therapy." It is our opinion that for the "occasional operator," one who does not frequently treat patients with peritonitis and varying types of appendicitis, it is probably better to remove the appendix when the patient is first seen. On the other hand, lives will be lost by this procedure which could have been saved by the proper institution of the conservative therapy by an experienced surgeon. Jopson and Pfeiffer believe that the treatment of appendicitis in children, of cases of delayed or fulminating gangrene and of cases in which intra-abdominal rupture of a localized abscess has occurred, should not be conservative.

The diagnosis of general peritonitis is easy. The patient does not recover well from the operation. The pain which was present before operation still persists, is diffuse in character, and is more or less dull in nature. Vomiting is almost invariably present. The abdomen is distended, tympanitic, and there is tenderness and rigidity over the entire abdomen. The pulse rate is increased and the temperature is elevated, often to a very high degree. As a result of the hyperpyrexia, the inability to take fluids, and the loss of fluids by vomiting, dehydration rapidly ensues. If untreated, the condition progresses, causing the death of the individual. This may also occur in spite of active therapy.

The treatment of peritonitis consists of conservatism. The patient is placed in the Fowler's position, so that any peritoneal exudate may gravitate into the cul-de-sac. Heat is applied to the abdomen in the form of an electric light tent or hot compresses. Nothing is given by mouth, not even water. Fluids, either normal saline or glucose solution must, therefore, be administered by proctoclysis, hypodermoclysis, or intravenous infusion. The demand for fluids is abnormally great, because of the increased metabolism attendant upon the hyperpyrexia and because of the constant loss of fluids by vomiting. The administration of 4 to 5 litres of fluid every twenty-four hours is ex-

tremely important, and should be instituted early and consistently continued. In prevention of severe dehydration this point cannot be overemphasized. If the patient vomits, repeated gastric lavage, employing large amounts of warm water, is indicated. Under certain conditions, the introduction of a duodenal tube is permissible. The total abstinence from food should be adhered to as long as there is any sign of peritoneal irritation.

Closely associated with, and usually the result of, peritonitis is ileus, which occurs as another post-operative complication of appendicitis. Fortunately, this complication is found less frequently than some of the other complications, but, because of its severity and its close association with peritonitis it should be considered with this condition. In all cases of peritonitis, especially the diffuse variety, a certain amount of ileus is present. In considering ileus in cases of appendicitis it is essential to differentiate between mechanical obstruction and the adynamic variety, the latter type being the one more frequently encountered, especially in the diffuse type of peritonitis. In the various statistical reports often no differentiation is made between these two types of ileus. It may be assumed, however, that all patients with a diffuse peritonitis have an adynamic ileus to a greater or lesser degree. It is considered by some that death in general peritonitis is not due to the toxemia from the peritonitis itself, but rather to the toxemia produced by the absorption of toxins from the paralytic, atonic bowel. It is obviously impossible to demonstrate the truth of such a statement, since two sources of toxemia are present, *i.e.*, the peritoneal cavity and the bowel. It is illogical to assume that one factor is more important than the other in absence of quantitative measurements (Table III). Ileus comprises from 6 per cent. to 15 per cent. of all post-operative complications of appendicitis.

Quain and Waldschmidt believe that the location of a gangrenous appendix in the mid-portion of the abdomen is especially dangerous, because of the danger of adhesions forming between the loops of bowel with a resulting obstruction. They advise an enterostomy at the time of the primary operation if there is a diffuse peritonitis.

Mann believes that if a purulent exudate is left in the pelvis at the time of operation a matting together of the intestines is apt to occur. This condition has been described previously by others. It has been shown by a number of observers that obstruction is very apt to occur in the region of the terminal ileum, especially in the cul-de-sac (Handley, Eisendrath).

Stillman had sequelæ develop in 124 cases (7 per cent. of all acute cases), all of which occurred post-operatively. The intra-abdominal complications numbered 47 (2.7 per cent.). There were 13 cases of acute ileus (7.8 per cent. of all the cases of sequelæ, 27.6 per cent. of the intra-abdominal complications). Of these 13 patients, 8 died (61.5 per cent. mortality). Of the 13 cases, 11 were operated upon and 1 was cured by enema, and in 1 case the diagnosis was established only at autopsy. The obstruction in the 12 cases which were re-operated upon was always in the small gut and was due to adhesions or angulation. In 8 the obstruction was close to the ileo-cecal valve; enterostomy was performed in 2 cases, enterorrhaphy in 2 cases, and aspiration of bowel to relieve pressure in 1 case.

The etiology in all cases is an antecedent or existing infection, the peritonitis being, almost invariably, the cause of the obstruction, both in the mechanical and the adynamic types. The incidence of this complication would

TABLE III—ILEUS

*Compilation of cases of acute appendicitis demonstrating the number of cases of ileus complicating this condition, as well as the percentage of deaths*

Author	Acute Appendicitis	Deaths	Per Cent. of Deaths	No. of Complications	Mechanical Obstr.	Per Cent. of Complications	Adynamic Ileus	No. of Complications	Combined Obstruc.	No. of Complications	Per Cent. of Deaths
Gatch and Burman.....	262 (205 "Pus Cases")	19	7						2		10
Bancroft.....	584	25	4.2	32					5 <sup>1</sup>	15	20
Dudley <sup>2</sup> .....	560	26	4.6						12		48
Schaer <sup>3</sup> .....	1,290	72	5.58						2		2.7
Quain and Waldschmidt.....	1,600	27	2.7						7		29
Stillman.....	865	46	5.3	{ 124 Intra-Ab. 47					13 <sup>4</sup>	{ 7.8 All (27.6 Intra-Ab. 6	
Cutler <sup>5</sup> .....	974	41	4	83	7	8.4	5	6	5	14	
Lett.....	698	30	4.8	14	27		17		2	14	
Deaver.....	2,385			155					44		
Ruge.....	1,179								7	4.5	

<sup>1</sup> Four of these patients died (mortality 80 per cent.).

<sup>2</sup> In these cases there were 48 cases of diffuse peritonitis at time of operation. Of this group 25 per cent. developed an adynamic ileus subsequently.

<sup>3</sup> No evidence of mechanical obstruction in cases with appendiceal abscess or diffuse peritonitis. Probably in these cases adynamic ileus is partially responsible for the death.

<sup>4</sup> Ileus occurred only after drainage. <sup>5</sup> Three hundred and ninety-two were suppurating.

TABLE IV—RESIDUAL ABSCESES

*Compilation of cases of acute appendicitis showing incidence of complications, with special reference to the number and type of residual abscesses*

Author	Acute Appendicitis	Complications	Per Cent. of Cases	Intra-Abdom. Complications	Per Cent. of All Complications	Number of Residual Abscesses	Per Cent. of Cases	Per Cent. of Complications	Per Cent. of Intra-Abdom. Cases	Cul-De-Sac	Per Cent.	Rt.-Sided	Per Cent.	Sub-Phrenic	Per Cent.	Left-Sided	Per Cent.
Stillman	545	124	7	47	38	24	4.4	12.5	19	12	50	4	16	9	37	2	8
Bancroft	584	71	12.3	32	45	27	4	38	84			10	55	2	33	2	11
Cutler	974 (392 Suppurative)	83	8.5	59	71	18	1.8	21	305			3	20	6			
Beekman	145	23	15	15	65	15	15	65	100			8	10	1	6.6	12 (7 Suspects)	11
Clairmont and Meyer	1,179 <sup>2</sup>	719	60	162	23	79	5.7	11	48	49 (67 Infiltration)	62	11	26	39	73	8	19
Sucrmont	630 <sup>1</sup>					42	6.8			23	54						
Wolf	250 Appendiceal abscess					10	4										
Truesdale	259																

<sup>1</sup> Secondary abscess in 1.6 of the non-drained and 6.2 per cent. of the drained cases.

<sup>2</sup> Only 8.8 per cent. were drained at the primary operation.

<sup>3</sup> 4.2 per cent. of all the acute cases of appendicitis had eul-de-sac involvement.

<sup>4</sup> 36 per cent. were drained at the Primary operation.

depend largely upon the length of time elapsing between the onset of symptoms and operation. Those cases in which the infectious process has spread beyond the appendix are more prone to develop this complication, because a peritonitis develops more frequently. The symptoms and signs of ileus are quite definite. The patient, in addition to exhibiting signs of peritonitis, as described above, is unable to pass flatus or stool. Vomiting, due to reverse peristalsis, is frequent. The vomitus, which at first contains gastric contents, later may become stercoraceous. Abdominal distention, at first not marked, later becomes a very prominent sign. Due to the elevation of the diaphragm an embarrassment of the respiratory and circulatory systems results. The abdomen, in addition to being distended, is abnormally tympanitic. Even though the diagnosis of ileus is not difficult, and, as has been said previously, every case of diffuse peritonitis is associated with a certain degree of ileus, it is often extremely difficult to differentiate between the mechanical and adynamic varieties. As a rule, the pain in the two types of ileus differs. In the mechanical variety the pain is characteristically colicky and intermittent; associated with this pain, and also the cause of it, there is increase in peristalsis in the gut proximal to the obstruction. This can often be seen and can always be heard. In the adynamic variety of ileus, on the other hand, pain is characteristically absent. Auscultation of the abdomen is of great value in a negative sense, because in adynamic ileus no sounds are audible. It must be kept in mind that an adynamic ileus may be superimposed upon and may follow a mechanical ileus. In fact, all cases of mechanical ileus which are not relieved are usually followed by the adynamic variety. In cases of suspected ileus a röntgenogram of the abdomen taken with the patient in an upright position without the introduction of contrast media is of distinct value in making a diagnosis. In ileus a typical picture is obtained. Due to the presence of large amounts of gas and fluid in the various loops of bowel, numerous fluid levels can be seen scattered throughout the abdomen. This finding is pathognomonic of intestinal obstruction.

*Treatment.*—The treatment of ileus developing post-operatively or following acute appendicitis is the same as that employed in ileus due to any other causes. The prime requisite in treatment is early diagnosis, so that the proper therapy might be instituted before a profound toxemia has occurred.

Haden and Orr have shown that associated with the toxemia in intestinal obstruction there are certain very definite and constant changes in the blood. These are: hypochloremia, an increase of the carbon dioxide combining power of the plasma, and an increase in the non-protein nitrogen of the blood. Because of these very constant findings, it is desirable in all cases of ileus to determine the amount of blood chlorides, the  $\text{CO}_2$  content of the plasma, and also the amount of non-protein nitrogen in the blood. In cases in which there is a decrease in the amount of blood chlorides, chlorides should be administered either subcutaneously or intravenously. As these patients are usually dehydrated, the administration of sodium chloride intravenously, either in a



normal or 1 per cent. solution, is of distinct value. Saline should be administered pre-operatively. The existing alkalosis is relieved by the replacement of the blood chlorides.

The operative procedure in cases of mechanical ileus consists of relaparotomizing the individual as soon as possible. In those cases in which the obstruction is due to the presence of bands of adhesions these are divided. This is often a simple procedure. If, however, there is evidence of disturbance in the circulation of the bowel, it is often necessary to resect portions of the gut. An enterostomy performed during the original operation was first executed by Heidenhain. This procedure has won considerable favor recently in those cases of peritonitis associated with adynamic ileus. Often the introduction of an enterostomy tube into dilated, atonic gut is of little value, as the tube drains only that small portion of the intestine in the immediate vicinity. Certain cases of adynamic ileus may be successfully treated by blocking the splanchnic nerves either by introducing an anæsthetic solution intraspinally or in the region of the splanchnics. The latter procedure has been performed by Ochsner, Gage, and Cutting in a large series of experimental animals, and also in clinical cases, with very satisfactory results. As a post-operative measure in all cases of ileus the administration of saline solution is imperative. Most authors believe that if an ileostomy is to be performed it should be done early. Dudley even advocates the suturing of the jejunum to the parietal peritoneum and the introducing of a large tube directly into the lumen of the gut rather than an enterostomy done according to the technic of Witzel.

*Residual Abscess.*—Intraperitoneal abscesses occurring post-operatively usually follow general peritonitis and in that sense are truly residual. In some instances, however, it is possible to have primary abscesses in parts of the peritoneal cavity other than the ileo-cecal region, where the usual "appendiceal" abscess is found. That residual abscesses are not only found in undrained cases is shown by Bancroft's series. He found secondary intra-abdominal abscesses in 1.6 per cent. of the non-drained cases of appendicitis and in 6.2 per cent. of the drained cases. Of the reported cases residual abscess occurred in from 1.8 per cent. to 5.7 per cent. of all cases of acute appendicitis (Table IV).

In addition to the usual type of secondary intra-abdominal abscess, Martin and Melchior have reported cases of late abscesses occurring intra-abdominally months and even years after the primary infection.

It is evident from statistics that the incidence of secondary abscesses occurring within the abdomen following acute appendicitis varies considerably, and, as Seurmondt's and Bancroft's series show, drainage of the peritoneal cavity does not seem to prevent the formation of this complication. There are certain definite sites at which these localized inflammatory lesions are more apt to occur. Localized inflammation occurs at these sites much more frequently than is commonly appreciated. The most frequent sites at which these inflammatory processes, which may or may not progress to abscess

formation, are apt to occur are: the cul-de-sac of Douglas, the ileo-cecal region, the subphrenic space, and the left iliac region (Fig. 1). In cases with secondary abscesses there are certain symptoms and signs which are common to all. The history in each is usually quite typical. A patient who has had acute appendicitis, in whom the appendix has or has not been removed, continues to have fever and to complain of abdominal pain. Associated with the elevation of temperature there is a leucocytosis. As a rule tenderness in the region of the localized infection can be elicited, if the localized infection can be approached by means of the examining finger. If the case is allowed to progress, the temperature curve assumes a hectic type. In addition to these general symptoms and signs, there are usually localized symptoms and signs which vary according to the site of the inflammatory process. These will be discussed under separate headings.

*Abscess of the Cul-de-sac of Douglas.*—In considering infections of the cul-de-sac it is essential to differentiate between simple infection of the peritoneal pouch, infiltration, and suppuration. At the present time the generally accepted treatment of acute appendicitis, especially those cases in

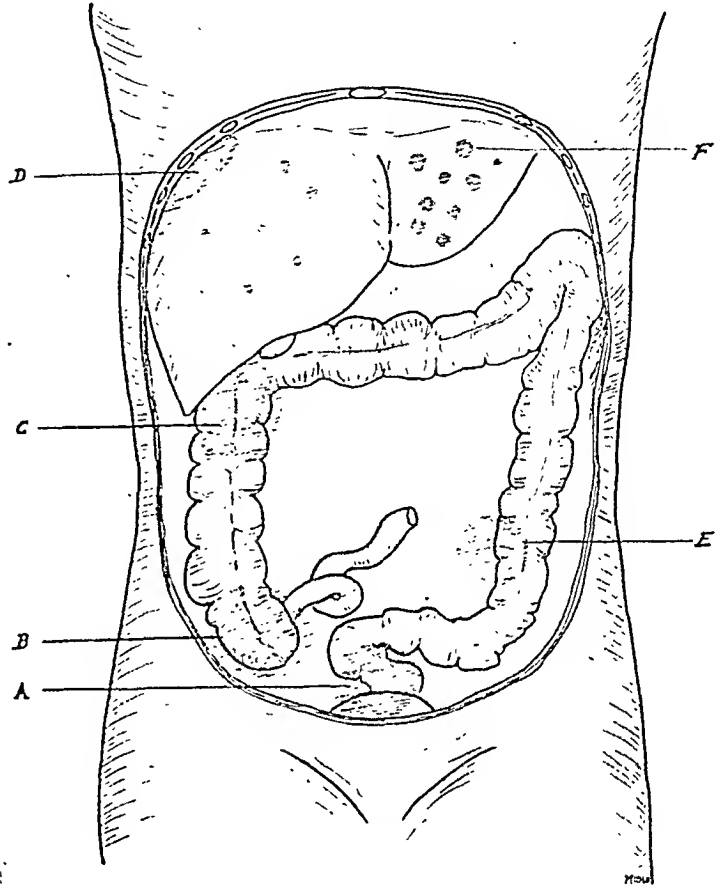


FIG. 1.—Diagrammatic drawing showing the various sites of localized suppurative processes within the abdomen following appendicitis. A—Cul-de-sac of Douglas infection; B—Ileo-caecal infection; C—Sub-hepatic infection; D—Supra-hepatic infection; E—Left-sided infection; F—Liver abscess, the result of pylephlebitis.

which the infection has extended beyond the appendix itself, consists of placing the patient either in Fowler's position or some modification of it. This is done for several reasons. Fowler believed that absorption was less from the pelvic peritoneum than the diaphragmatic peritoneum. Whether or not absorption is less from the pelvic peritoneum is still an open question. In all probability more toxic material is absorbed from the diaphragmatic peritoneum not because of the difference in the character of the peritoneum itself, but because of the constant massaging of the diaphragmatic peritoneum as the result of respiratory movement. Another equally, if not more, important reason for attempting to favor drainage into the cul-de-sac of Douglas is

that if a secondary inflammatory process or abscess results, it is in a position which is surgically more accessible than in some other parts of the abdomen. With the patient in the extreme Fowler's position the cul-de-sac of Douglas is the most dependent portion of the peritoneal cavity, and in cases of peritonitis there is a tendency for fluid and exudate to gravitate into this pouch. Pathologically three types of cul-de-sac infection must be differentiated: (1) those in which the pouch is filled with inflammatory exudate which has gravitated to the pelvis from other parts of the peritoneal cavity, producing local peritonitis; (2) those in which the inflammatory process has become walled off from the rest of the peritoneal cavity; and (3) those in which suppuration has occurred.

Nather and Ochsner reported 62 cases of cul-de-sac infection among 700 cases of acute appendicitis observed in the Zürich Surgical Clinic. In 27 per cent. of the cases of acute appendicitis the peritoneal exudate present at the primary operation was found to be sterile. In another 46 per cent. there was either no bacteriological examination made or no exudate was present. Thirty-nine (5.6 per cent.) showed evidence of only Douglas infiltration, and responded to conservative therapy. Of the 39 cases with secondary abscesses in the cul-de-sac 25 had been closed at the primary operation without drainage. There were 14 cases in which at the time of the original operation the cul-de-sac was found to be filled with pus. In 3 of these drainage was instituted through either the vagina or rectum. All of these patients died. The remaining 11 cases were drained by means of rubber tube and gauze extending from the cul-de-sac out through the abdominal wound. In 3 of these patients so treated a Douglas abscess resulted, necessitating subsequent drainage. Thus, a definite abscess developed in 18.1 per cent. of those cases in which there was primary drainage of the peritoneal cavity and 27.2 per cent. of those in which there was primary drainage of the Douglas pouch.

Barnes has recently emphasized the importance of this complication, and makes a plea for its recognition at the time of original operation so that the subsequent development may be prevented.

*Signs and Symptoms.*—The general signs and symptoms have been discussed above. Because of its relative inaccessible location, a collection of fluid or an inflammatory process in the cul-de-sac of Douglas often, and usually, gives rise to no symptoms, unless there is an involvement of some of the surrounding viscera. For this reason, it is essential and imperative in all cases of acute appendicitis in which infection has spread beyond the appendix itself, and especially those in which the patient has been placed in Fowler's position, to examine the rectum post-operatively. As the inflammatory process will probably occur within the first week post-operatively, this examination should be performed at least every other day for a period of days. It is essential that both the rectum and bladder be empty. In those cases in which the Douglas pouch is filled with inflammatory exudate a bulging of the anterior rectal wall can be felt. As the infection progresses an

induration, which appears as a hard, painful tumor, can be palpated. If sup-  
puration occurs, a soft fluctuating area within the indurated mass becomes  
evident. In order to appreciate the changes occurring in a cul-de-sac infec-  
tion, it is essential to examine these patients frequently. Due to the location  
of the inflammatory  
process, there is  
often an associated  
irritation or infec-  
tion of the bladder  
and rectum. As the  
result of these  
changes, the patient  
complains of cer-  
tain symptoms.  
Difficulty in defeca-  
tion was observed  
in 50 per cent. of  
Nather and Ochs-  
ner's series. Diar-

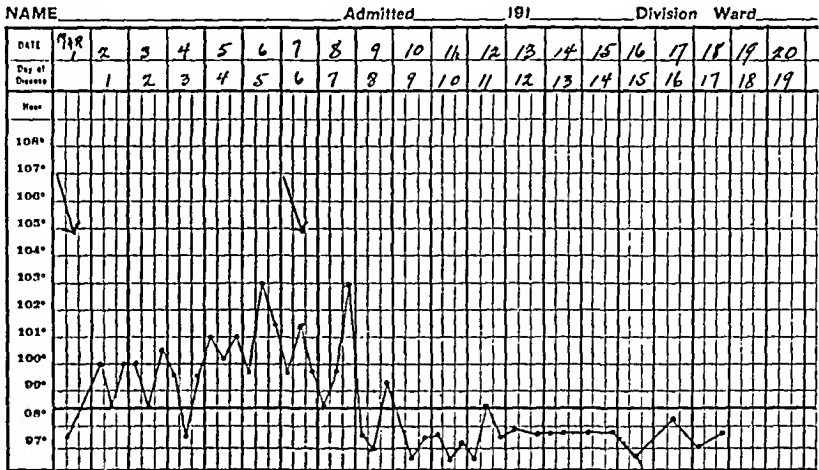


FIG. 2.—Temperature curve usually found in cases of cul-de-sac infection. The temperature immediately after the appendectomy, as indicated by first arrow, steadily rose until an abscess in the cul-de-sac of Douglas was drained, as indicated by the second arrow. Following this, the temperature fell.

rhœa, with an increase in mucous secretion, was observed in 40.7 per cent. of  
their series, whereas severe constipation was present in 7.7 per cent. In addi-  
tion to these rectal symptoms, the patient often complains of bladder symp-  
toms, especially urgency, frequency, and a sense of pressure in the region of

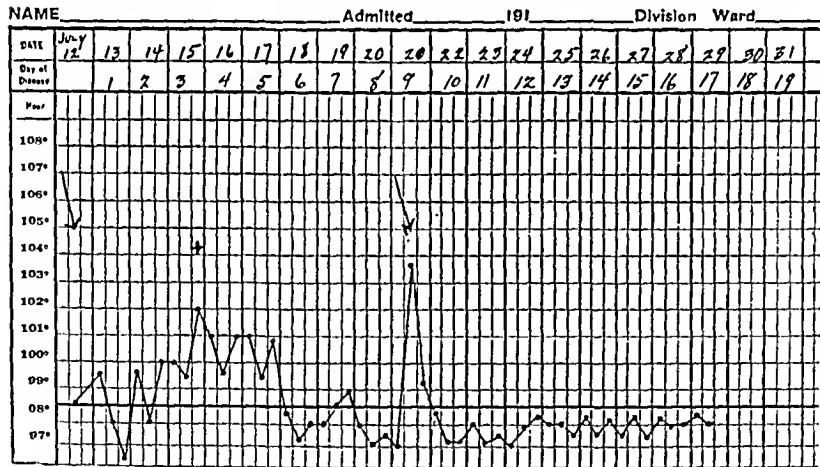


FIG. 3.—Second type of temperature curve found in Douglas abscess. The first arrow indicates the appendectomy. At the + an abdominal wall abscess was opened. Following this, the temperature fell to normal to rise abruptly on the tenth post-operative day, at which time, as indicated by the second arrow, an abscess in the cul-de-sac of Douglas was drained.

the bladder. A  
very important  
diagnostic sign  
in these cases, espe-  
cially in those in  
which suppuration  
is present, is a  
marked relaxation  
of the anal sphinc-  
ter. This is due  
to a paresis of the  
rectal and anal  
musculature. The  
mucosa of the rec-  
tum becomes thick-

ened, cedematous, and succulent. The diagnosis of a Douglas infection is not  
difficult if the condition is considered, and any case of acute appendicitis  
which is not progressing satisfactorily should be examined rectally, in order  
to determine the presence of this complication. The rise in temperature  
caused by an abscess in the cul-de-sac of Douglas usually appears on the  
sixth or seventh day. Nather and Ochsner have described three types of  
temperature curves in cases of cul-de-sac abscess.

*Type 1* is that in which the temperature rises consistently after the appendectomy, until the opening of the Douglas abscess. They found that 54.1 per cent. of their cases were in this group. (Fig. 2.)

*Type 2* is that in which the temperature falls to normal and, after seven or eight days, again rises until the abscess is relieved by drainage. Thirty-seven and one-half per cent. of the cases were in this group. (Fig. 3.)

*Type 3* is that in which the temperature characteristically rises several days after the appendectomy, as the result of a subcutaneous abdominal infection. The temperature again falls to normal and remains low for 2 to 2½ weeks, and is followed by an increase in symptoms and a return of fever, which are the result of the cul-de-sac infection. 8.4 per cent. in the group. (Fig. 4.)

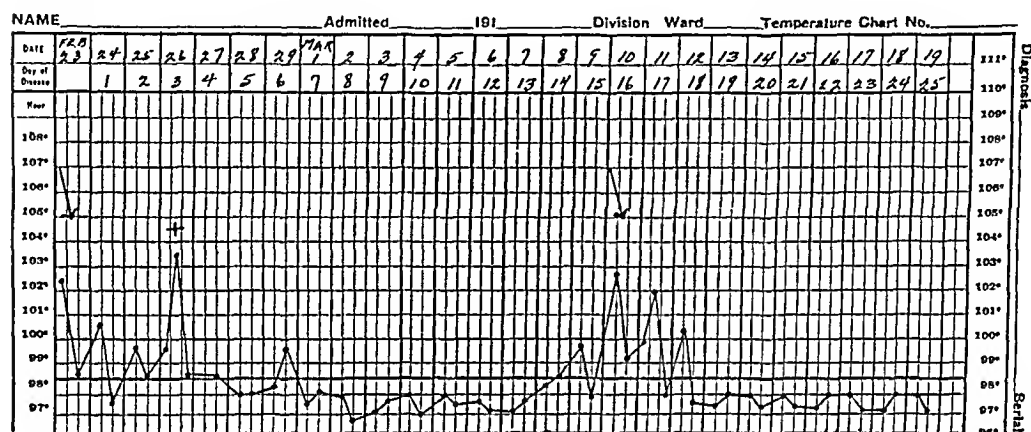


FIG. 4.—Third type of temperature curve as seen in cases of abscess of cul-de-sac of Douglas. The first arrow indicates the original operation. The + indicates the drainage of an abdominal wall abscess, following which the temperature fell to normal and remained so until the fifteenth post-operative day, when it rose suddenly again. The second arrow indicates the drainage of an abscess in the cul-de-sac.

If the process is allowed to progress, a definite abscess may form. Spontaneous resolution, however, may occur in those cases in which infiltration is present.

*Treatment.*—The treatment of cul-de-sac infection is, first, prophylaxis. The presence of fluid, either purulent or non-purulent in the cul-de-sac, predisposes to the development of a post-operative Douglas pouch infection. Barnes emphasizes the importance of recognizing such collections of fluid at the original operation, and advises aspirating the fluid by means of a soft rubber tube. It is essential to completely evacuate the pouch of the contained material at the time of the operation. After inflammation or infiltration has occurred in the cul-de-sac, the treatment is first conservative, as many cases subside spontaneously. The conservative treatment in this condition is the same as that advocated for peritonitis. In addition, it is desirable, whenever possible, to apply heat to the region of infection. For this Nather and Ochsner have advised a modification of the Arzberger cannula, by means of which heat may be applied, through the rectum to the infected area. Under

such therapy the inflammatory process will either resolve or suppurate. As soon as suppuration has occurred, as evidenced by a softness and fluctuation in the centre of the indurated area, radical therapy is indicated. The operative therapy consists of drainage of the abscess through either the rectum or the vagina. Nather and Ochsner advise the routine drainage of these abscesses through the rectum, and in their 39 cases so treated had no untoward complications develop. The drainage of a cul-de-sac abscess through the vagina of the female, however, is permissible, but, because the condition may develop in males, it is probably advisable to have one routine technic by which these abscesses may be drained. The danger of infecting the peritoneal cavity by draining the abscess through the rectum is nil, as the abscesses are walled off from the peritoneal cavity.

The operation is best performed under local or sacral analgesia. It is seldom necessary to dilate the sphincter, because of the paralysis of the sphincter described above. A large aspirating needle is inserted in the fluctuating area, and as soon as pus is aspirated with the needle left *in situ* a longitudinal incision is made alongside the needle, opening the abscess. After the abscess has been incised, it is further opened, by means of forceps, and a large rubber tube inserted, which is brought out through the anus. The tube is secured in place by means of a T-bandage. As a post-operative measure the patient is given morphine in small doses over a period of two to three days, in order to prevent defecation. The drainage tube usually comes away with the first bowel movement, and it is practically never necessary to re-insert it. Within two to three days after the drainage of the abscess, the temperature becomes normal, and within eight to ten days all evidence of the inflammatory process subsides.

*Ileo-cecal Abscess.*—An infection in the ileo-cecal region is less apt to occur than in other parts of the peritoneal cavity, especially when drainage has been instituted at the time of the primary operation. Clairmont and Meyer report 8 para-cecal abscesses among 1,179 cases of acute appendicitis and 3 abscesses located partially on the right side, but which extended to the suprapubic region. Of 18 interaperitoneal abscesses reported by Cutler 10 (55 per cent.) occurred in the region of the cæcum. Here, as in the cul-de-sac of Douglas, the type of inflammation varies from simple infection to suppuration. The symptoms and signs are the same as those of all intra-abdominal abscesses. In addition, the patient complains of pain in the right lower quadrant of the abdomen in the region of the wound. Examination reveals tenderness and rigidity, which, however, often may be confused with wound tenderness. As an uncomplicated wound should not remain tender longer than one to two days, little difficulty should be encountered in making a correct diagnosis. Here too, as in the cul-de-sac infection, resolution may take place without the production of a suppuration. If, however, suppuration occurs, a definite mass, which is tender, is palpable in the right iliac fossa. Before suppuration occurs, it is impossible to tell whether the tumor is an

inflammatory exudate or abscess. This type of abscess offers very little difficulty as far as diagnosis is concerned.

The treatment of these cases is the same as that employed in peritonitis. It is essential, even in those cases in which the process is localized, to treat the patient as if he had a generalized peritonitis, *i.e.*, he should be given nothing by mouth, in order to avoid increasing peristalsis. In this way there is relatively little danger of the infection in being disseminated from its position in the right iliac fossa throughout the general peritoneal cavity. Heat should also be applied in the form of large, hot, moist dressings, which should be renewed every one to two hours. Occasionally it is advisable to alternate the moist dressings with dry heat in the form of an electric light tent. Most cases subside under this conservative therapy. If, under the conservative therapy, the fever continues, the mass in the right lower quadrant persists, and other signs and symptoms do not regress, operative interference is justified after one is certain that the process has become walled off completely. The operative procedure consists of incision and drainage, without opening the peritoneal cavity. Within a few days after the institution of drainage the abscess cavity becomes obliterated.

*Left-sided Abscess.*—A left-sided abscess is a relatively rare complication following acute appendicitis. Sprengel is of the opinion that a left-sided abscess may occur in either one of two ways. It may be associated with a cul-de-sac abscess and rise out of the pelvis. In case gravitation is prohibited into the pelvis by a blockage of the pelvic inlet, pus may pass to the left side and up along the sigmoid, and produce a localized inflammatory process. Nather and Ochsner, during a four-year period, in which 700 cases of acute appendicitis were observed in the Zürich Clinic, found 9 cases of left-sided abdominal abscess. Clairmont and Meyer reported from the same clinic, during a five-year period, 1,179 cases of acute appendicitis observed, among which there were 12 cases of left-sided abscess and 7 cases of left-sided infiltration. Moschowitz believes that in all cases in which there is an irritative exudate of the peritoneum it is possible to have a localization on the left side with the production of left-sided abscess. Schlange is of the opinion that all multiple abscesses in the peritoneal cavity follow a general peritonitis.

The possibility of a left-sided abscess complicating appendicitis in an individual with situs inversus viscerum must not be forgotten. Types of abscess occurring on the left side are (1) the usual form which is similar to typical right-sided appendiceal abscess, and is bounded below and laterally by Poupart's ligament and above and medially by the adherent loops of intestine; (2) the unusual type, which is located at a higher level, as a rule on a line connecting the two anterior superior spines. This type of an abscess is especially prone to occur in children. In 4 of the 9 cases reported by Nather and Ochsner the age was less than thirteen years. Royster states that two-thirds of the left-sided abscesses observed by him were in patients under twelve years of age.

The signs and symptoms are the same as those present in right-sided

abscesses, except that the pain, tenderness, and rigidity are located on the left side instead of the right. The condition almost invariably occurs in those cases of appendicitis in which the process was not limited to the appendix at the time of the original operation.

The treatment consists of rest in bed and the application of heat to the abdomen, preferably in the form of large, moist dressings, alternating with the application of dry heat in the form of an electric light tent. In these cases also spontaneous resolution usually ensues. If, however, resolution does not occur and suppuration results, incision and drainage are indicated. The incision is made directly over the abscess and, whenever possible, the abscess should be opened without entering the free peritoneal cavity.

*Subphrenic Abscess.*—The occurrence of subphrenic infection in the course of acute appendicitis is not as rare as is commonly supposed or as one would surmise from the statistical reports. The incidence of subphrenic abscess varies from 6.6 per cent. to 73 per cent. of all residual abscesses (Table IV).

In order to understand the symptomatology and pathology of subphrenic abscess, it is necessary to have some knowledge of the anatomy of the subphrenic space. It is not within the realm of this paper to discuss the anatomy of this area in detail, as this has been done previously. Suffice it to say that the most frequent sites of localization for subphrenic infections following appendicitis are (1) the right posterior superior space, which is a relatively small area located above or posterior to the liver and posterior to the left lateral ligament, (2) the right inferior subphrenic space, which is located below the liver to the right of the round ligament and ductus venosus. It is not uncommon to have a supra-hepatic and an infra-hepatic infection occurring simultaneously. The anatomy of this region has been carefully studied by Martinez, Picuands, Barnard, Nather, and Ochsner.

Infection of the subphrenic space probably occurs in a number of different ways: (1) As has been emphasized by Eisendrath and others, the infection may extend upward along the paracolic groove to the right kidney pouch and thus invade the subphrenic region. This is probably the most frequent mode of infection.

(2) Munro has emphasized the possibility of a retro-peritoneal lymphangitis, causing infection of the subphrenic space;

(3) A subphrenic infection may be the result of a general peritonitis, the process remaining in the subphrenic space as a residual infection;

(4) The involvement of this space may follow multiple liver abscesses, which result from pylephlebitis;

(5) Another possibility is that the infection may extend upward retro-peritoneally as a phlegmon without passing through the medium of the lymphatics.

Ullman and Levy believe that those infections which occur as the result of a direct extension are located intra-peritoneally, whereas those which follow infections of the cellular tissues are retro-peritoneal and those which



extend by the lymphatic system may be either intra- or extra-peritoneal. As has been mentioned above, subphrenic infections are not infrequent; relatively few, however, suppurate. Neuhof states that most of the non-suppurative subphrenic infections are not diagnosed for two reasons: (1) because the infection is not fatal and cannot be determined at autopsy, and (2) because exploratory punctures are more frequently resorted to than exploratory incision. He reported 15 cases of non-suppurating subphrenic peritonitis complicating appendicitis which occurred among 972 cases of acute appendicitis (1.5 per cent.). In all cases there were typical signs of subphrenic infection. All patients recovered. Lee reported 4 cases of subdiaphragmatic infection which did not progress to abscess formation, all of which presented typical signs and symptoms of subphrenic infection, and in all, the symptoms subsided spontaneously. Clendening and Ochsner have called attention to the fact that subphrenic infections occur not infrequently and may subside spontaneously.

*Symptoms and Signs.*—The general symptoms of subphrenic infection do not differ from those of any localized infection within the abdomen. In addition to these, there may be relatively few other symptoms. In fact, the condition often is permitted to persist for weeks or months. Unfortunately, there are no early symptoms of subphrenic abscess. Here, as in cul-de-sac infections, it is essential to consider the condition in all cases of acute appendicitis which do not progress satisfactorily. In this way a diagnosis usually can be made relatively early. As a rule long before the patient complains of any pain a definite localized point of tenderness may be elicited over the tip of the twelfth rib on the right side. In those cases with infection in the infra-hepatic space tenderness and rigidity can be elicited in the right subcostal region. The patient may complain of pain in the lumbar region next to the vertebral column; the pain at times may be referred to the supraclavicular region through the phrenic nerve. If the condition is allowed to progress without the institution of therapy, an irritative pleurisy is apt to result, due to the passage of toxins through the diaphragmatic lymphatics. For this reason, these cases are often misdiagnosed as pleurisy. It might be said, at this point, that any individual who is recovering from an acute attack of appendicitis and who develops a pleurisy should be considered as having a localized infection in the subphrenic space until proven otherwise. Preceding this, however, there is evidence of decrease movement of the affected leaf of the diaphragm. These two phenomena can best be observed fluoroscopically. The text-book picture of subphrenic abscess which is given so often is seldom seen. The high elevation of the diaphragm, below which a gas collection overlies fluid, represents a late stage of the condition. Unless there has been perforation of a hollow viscus, allowing the escape of gas into the free peritoneal cavity, this picture should never be seen in subphrenic abscess, as it indicates a considerably delayed diagnosis. We agree with Lockwood and Hodges that an exploratory puncture is not justifiable in suspected cases of subphrenic abscesses, because of the danger

of infecting a virgin pleural cavity. The only justification for it is to determine the type of pleural fluid in those cases in which empyema might be suspected.

The prognosis in subphrenic abscess is bad. The mortality of the reported cases varies from 23 per cent. to 100 per cent. (Douglas 33 per cent.); Hodges, 50 per cent.; Eicher and Kidzey, 50 per cent.; Bauman, 66 per cent.; McEachern: cases operated—33 per cent., not operated—75 per cent.; Tuft, 66 per cent. Fifield and Love report a mortality of 50 per cent. in all their cases. Of 59 cases operated upon there was a mortality of 32 per cent. Lockwood states that in the unoperated cases there is a mortality of from 85 per cent. to 100 per cent., whereas in the operated cases there is a mortality of 66 per cent. Of 15 cases reported by Ochsner there was 1 death, a mortality of 6.6 per cent.

*Treatment.*—The treatment of subphrenic infection may be divided into three types: (1) Prophylactic treatment, which consists of placing all patients with generalized peritoneal infection in the extreme Fowler's position and an institution of the other measures employed in peritonitis. The conservative treatment in late cases of appendicitis will prevent many subphrenic infections. Fifield and Love found that in 228 cases treated conservatively at the London hospital a subphrenic abscess occurred in only 1 case, whereas in 1,109 cases subjected to immediate operation 7 were complicated by subphrenic abscess.

(2) Conservative treatment: In all cases of subphrenic infection conservative treatment is indicated, as most of these subside spontaneously. When the proper conservative therapy is instituted, it is usually not necessary to resort to operative therapy. The conservative treatment consists of immobilization of the affected side by means of adhesive plaster, the application of heat to the affected side, preferably in the form of dry heat, in addition to the general supportive measures as outlined above.

(3) Treatment of the abscess *per se* consists of incision and drainage. Because of its location a subphrenic abscess offers certain technical difficulties in approaching it. The two routes which have been most frequently used are the transpleural and the transperitoneal. The drainage of any suppurative process through an uninvolved serous cavity is not, however, a sound surgical principle. The results obtained following such a procedure bear out this statement. Fifield and Love report a mortality of 43.7 per cent. in those cases which were drained transpleurally, a mortality of 23.8 per cent. in those drained through the abdominal wall and a 16.7 per cent. mortality in those drained through the loin. That an infection of either the pleural or peritoneal cavity is responsible for the high mortality is probable. It is not only possible and desirable but imperative in all cases of subphrenic abscess to drain extrapleurally and also extraperitoneally. An abscess located in the right superior posterior space, which is the most frequent site of a subphrenic abscess complicating appendicitis, is best drained by the retroperitoneal route. This technic has been described in detail in

previous publications (Nather and Ochsner), and will be only mentioned here. It consists of resection of the twelfth rib, following which a transverse incision is made through the soft parts at the level of the spinous process of the first lumbar vertebra. In this way the pleura is avoided. The incision is carried down to the renal fascia which is continuous above with the peritoneum. The renal fascia is followed upward to the peritoneum, which is then readily separated from the under surface of the diaphragm. A needle is inserted into the subhepatic region, in order to determine whether or not there is an associated subhepatic abscess. If no pus is obtained, separation of the peritoneum from the under surface of the diaphragm is continued until the abscess on the upper surface of the liver is encountered. By means of the finger the abscess cavity is opened and drained without passing through uninvolved peritoneum or pleura. In those cases in which the abscess points anteriorly a similar procedure may be used, as first advocated by Clairmont. An incision is made along the costal margin down to the peritoneum. Without opening the peritoneal cavity the peritoneum is dissected from the under surface of the diaphragm until the abscess cavity is reached. This cavity also is opened bluntly without transversing the free peritoneal cavity. By employing the retroperitoneal operation Ochsner reported 15 cases of subphrenic abscesses complicating appendicitis, with a mortality of 6.6 per cent.

Laurell and Westerborn have recently demonstrated that in many cases with intra-abdominal residual abscesses a flat röntgenogram of the abdomen is of value in localizing the suppurating processes.

The following case is reported because of the development of many of the above-mentioned complications, *i.e.*, right iliac infection, left-sided infection, subphrenic infection, and cul-de-sac abscesses.

E. K.—(Fig. 5); white; female; aged twelve years. Admitted to the Charity Hospital, December 26, 1928, with temperature of 101.8, pulse 124, and respiration 24, complaining of pain in the right side of the abdomen. Onset of symptoms was forty-eight hours previously, beginning with pain and nausea. Vomiting appeared twenty-four hours later. Pain was worse in umbilical region. At the end of twelve hours it became localized in right side, but upon admission to the hospital pain was diffuse. History of fever 102 degrees on day prior to admission; no previous attacks similar to present one. Usual diseases of childhood. Family history irrelevant. Upon examination the child exhibited very little evidence of acute pain and did not seem extremely toxic. The physical examination was negative except that the abdomen was found to be diffusely rigid and tender, especially in the right lower quadrant.

The blood, on examination, showed: Red blood cells—4,520,000; white blood cells—28,100; 6 per cent. small mononuclear; 10 per cent. large mononuclear; 84 per cent. neutrophils.

Urinalysis showed a slight trace of albumin with many red blood cells, but was otherwise negative.

Patient was put to bed in Fowler's position; heat applied to the abdomen; nothing given by mouth; proctoclysis of glucose, 5 per cent. and normal saline, and hypodermoclysis of saline administered. Conservative treatment continued with improvement until December 30, 1928, when patient developed a right parotiditis with elevation of temperature to 101.4. Heat applied to face and gum given to chew. The temperature

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FIG. 5

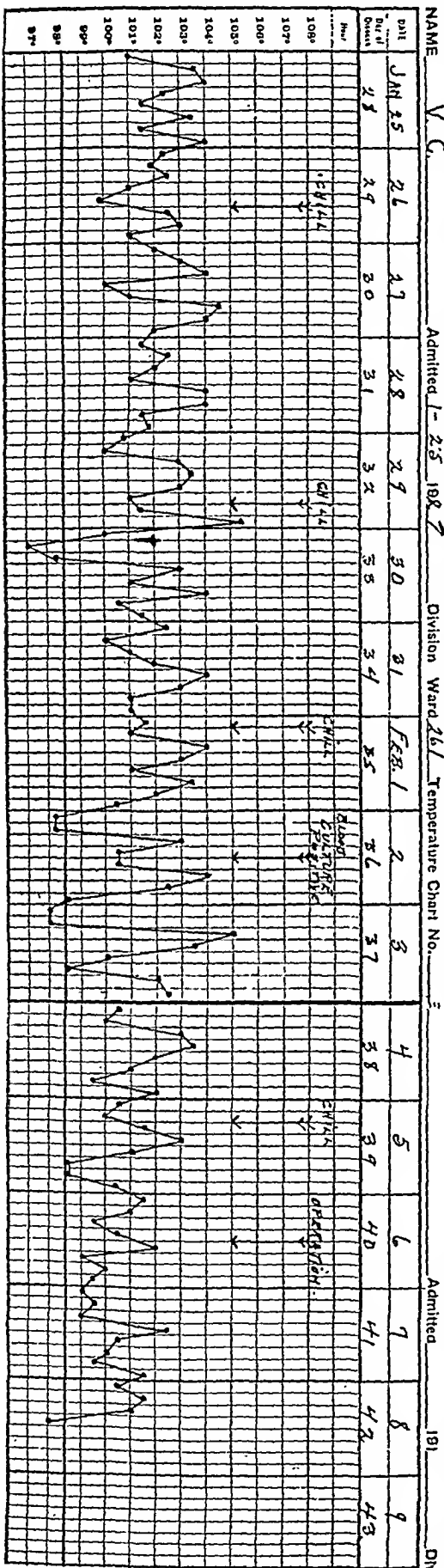
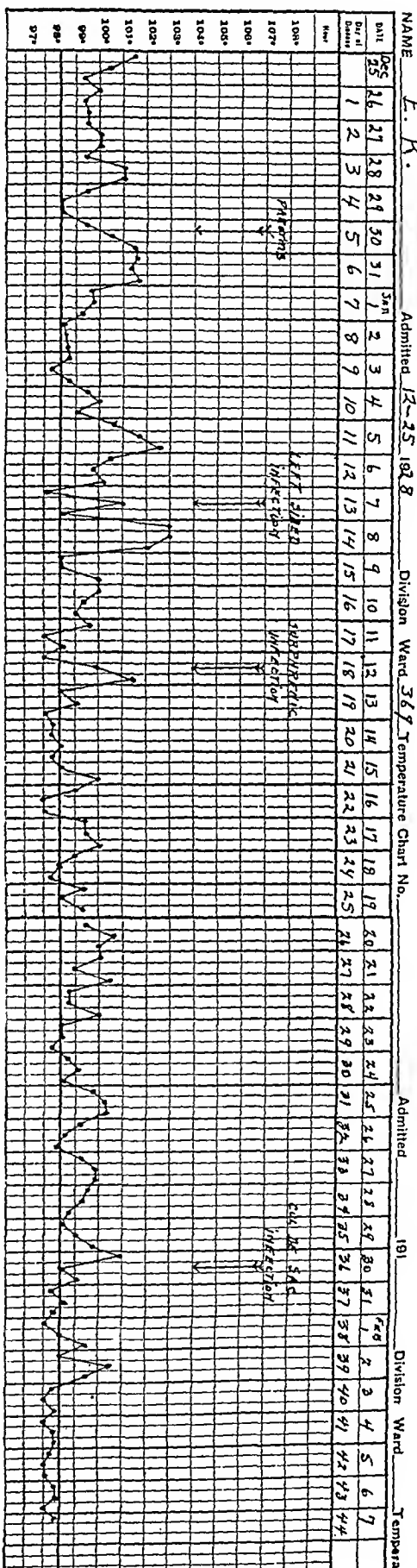


FIG. 6

Fig. 5.—Temperature curve of patient E. K., who developed a number of complications following appendicitis. The first arrow indicates a rise in temperature caused by a parotiditis, the second arrow indicates the development of a left-sided infection, the third arrow indicates the development of a subphrenic infection, and at the fourth arrow a cut-de-sac abscess had developed, which drained spontaneously through the vagina.

Fig. 6.—Temperature chart of V. C. Patient admitted to hospital with pyelitis. The first three arrows indicate the occurrence of chills. At the fourth arrow a positive blood culture was obtained. The sixth arrow indicates an operation, at which time a large liver abscess was drained.

gradually returned to normal on January 3, 1929. On January 5, 1929, patient began to complain of pain in left side of abdomen. Abdomen was greatly distended. Palpation of the abdomen showed a definite rigidity in the left lower quadrant just above Poupart's ligament, and upon rectal examination a marked tenderness was elicited in left side of the pelvis. Temperature was 102.4 on January 5, 1929. Conservative treatment was continued and patient was supported by hypodermoclysis and proctoclysis, there being nothing allowed by mouth. Temperature reached a maximum of 103 on January 8, 1929, accompanied by exacerbation of pain in the left side. Improvement was slow, but temperature became normal on January 11, 1929. The next day, however, the patient complained of pain in the right hypochondrium and exhibited symptoms of sepsis, a few signs of acidosis, and a temperature of 101.6 degrees. Glucose, 5 per cent., 500 cubic centimetres, was given by infusion. Symptoms began to subside and temperature became normal on January 14, 1929. From January 15, 1929, to January 30, 1929, the patient gradually improved but ran a hectic temperature from 100.4 to normal. On January 30,

TABLE V  
PYLEPHLEBITIS

*Compilation of cases of acute appendicitis showing the incidence of pylephlebitis*

Author	Cases of Acute Appendicitis	Cases of Pylephlebitis	Per Cent. of Cases	Author	Cases of Acute Appendicitis	Cases of Pylephlebitis	Per Cent. of Cases
Stillman.....	545	2	.14	Gibson.....	782	1	.13
Hoffman.....	4,000	7	.17	Braun.....	600	8	1.3
Moschowitz....	1,529	7	.45	Colp.....	2,841	9	.3
Brutt.....	2,500	15	.61	Reock.....	147	2	1.3
Gerster.....	1,187	9	.76	Bell.....	1,726	8	4.6
Quertz.....	533	4	.75	Petren.....	170 <sup>1</sup>	14	8.2
Clairmont and Meyer.....	1,187	4	.33	Armstrong....	546 <sup>1</sup>	28	5.1
Fitz.....	257	11	.4	Langdon-Brown <sup>2</sup> .....	9,494	12	.12
	Suppurative						

<sup>1</sup> Fatal cases of appendicitis.

<sup>2</sup> Necropsies.

1929, the temperature was 101 degrees, and rectal examination showed bulging, tenderness, and induration on the anterior wall of the rectum. On January 31, 1929, under ethylene anæsthesia, anal sphincter dilated. No pus could be aspirated from the mass felt in the cul-de-sac. At this time a discharge from the vagina was noticed. It was thought probable that the cul-de-sac abscess had ruptured spontaneously into the vagina. Drainage from the vagina continued and temperature became normal on February 2, 1929. All symptoms subsided and on February 16, 1929, abdominal operation was performed under ethylene anæsthesia. The appendix was removed and the peritoneal cavity carefully explored. Adhesions were found between the superior surface of the right lobe of the liver and the diaphragmatic peritoneum. The omentum in umbilical region was adherent to loops of small intestine, and in the left lower abdominal quadrant these adhesions were divided. The post-operative course has thus far been uneventful.

*Portal Thrombophlebitis or Pylephlebitis.*—Loisson gives Waller credit for first describing, as early as 1846, a suppurative portal phlebitis and hepatic abscesses following a perityphilitic infection. From the accompanying table (Table V) it can be seen that this complication occurs frequently enough to be appreciated. The incidence varies, according to different statistics, from about .1 per cent. to 1 per cent. of cases of acute appendicitis,

and occurs in about 5 per cent. of patients dying of peritonitis. Polya believes that pylephlebitis occurs in from .5 per cent. to .7 per cent. of all cases of acute appendicitis and in 5 per cent. of all the fatal cases. That appendicitis may be the most frequent cause of a pylephlebitis or liver abscess has been stressed by many. Brugemann states, "We now know that in the non-tropical country appendicitis is the most common cause of hepatic abscess." Hart, however, found that of 17 cases of liver abscess, resulting from infection of the portal vein, the infection originated in the appendix in only 3. Although it is possible to have an infection of the portal system in cases of appendicitis which have not perforated, this occurrence is rare. As described by Aschoff, an inflammatory process in the appendix, if allowed to progress, produces an infarction and thrombosis in the venules of the appendix. This process may extend to the larger vessels of the meso-appendix and produce a necrosis of the entire appendix. The blood supply of the wall of the appendix nearest the mesentery is poorer than elsewhere. Infection at this point is more likely to extend deeply into the meso-appendix. Infected thrombi may extend from the appendiceal vein through the ileocolic vein, the superior mesenteric vein, the portal vein, and into the liver. Thalheimer has shown that frequently in acute appendicitis thrombosis of the appendiceal vessels occurs. Dieulafoy, in a masterful exposition, stated that liver lesions may occur in cases of appendicitis with or without perforation of the appendix. He observed that the infected veins, in one of his cases, became varicosed. He did not believe, however, that organisms gain entrance to the veins of the appendix before the fifth or sixth day. Liver infection may occur by direct extension of the thrombo-phlebitic process in the portal vein, up to the liver, or may be the result of infected emboli which have been carried from the appendiceal veins through the portal system to the liver. It is possible that the portal vein may become secondarily infected from a retroperitoneal phlegmon which has extended up from the appendiceal region. (Melchior.) This, however, is relatively rare. In a case reported by Christopher only portions of the portal vein were destroyed, whereas the other portions were perfectly intact. The blood carried by the portal system from the appendix passes to the liver. Copher and Dick have shown that in the portal vein there are distinct currents which pass from various parts of the portal system to definite portions of the liver. They have shown that when a dye subsidence was injected into a small vein, at the root of the meso-appendix, it was transported to all parts of the liver. A greater proportion of the dye was, however, carried to the left lobe of the liver. Thus, in portal infection it can be seen that multiple abscesses may occur in either the right or left lobe. Probably there is a preponderance of the abscesses on the left side. Such an abscess has been reported by Lissner and Christopher. Right-sided abscesses have been reported by Barnes and Pearson, Babler, Colp, and Burgemann. Whereas the abscesses encountered in pylephlebitis are, as a rule, multiple, single abscesses have been reported by Quénu and Mathieu, who, in addition to

their own cases, collected two unpublished cases of Jalaguier and 14 others in the literature. All of these cases were operated on; 12 recovered, and 2 died of other complications. Solitary abscesses have been reported by Burgemann and Eliason.

The prognosis in this condition is extremely bad. Dieulafoy states, "This hepatic infection is one of the most dangerous complications of appendicitis, because I am only acquainted with two cases which have recovered." Lissner is of the opinion that no operative procedure will save a patient once the infection has gotten into the portal vein. Thalheimer has also emphasized the bad prognosis. In spite of the bad prognosis, not a few number of recoveries have been reported (Kelly, Hillstroem, Quénu and Mathieu, Scott, Colp, Farmer, Brogden, Eliason, Reock, Melchior, Braun, Brugemann, and Barlow).

*Symptoms and Signs.*—The symptoms and signs of pylephlebitis are quite characteristic—so much so that it is an omission on the part of the surgeon to overlook this condition when these signs and symptoms are present. It is only necessary to keep the condition in mind, in order to be able to make a diagnosis. Gerster, in 1903, stated, "Chills accompanied by a rapid rise in temperature during the course of appendicitis, however mild as to local symptoms, may, and usually do, signify the entrance of a septic material into the portal and general circulation. It must be looked upon as a sign of gravest importance." This important observation was little heeded until the past decade. Thalheimer, in 1921, emphasized the importance of chills occurring pre-operatively in cases of acute appendicitis, and urged that at the time of the original operation examination be made of the vessels in the ileo-colic and mesenteric vessels. He considers that the most important single symptom in pylephlebitis is the presence of chills followed by high temperature, and believes that all patients with acute appendicitis should be asked if they have had chills previous to admission to the hospital. If chills have occurred, the probability of a beginning thrombosis of the appendiceal vessels and possibly of some of the larger radicles of the portal system should be considered. Melchior believes that there are two types of appendicitis which are apt to cause portal infection. First, those in which the portal infection occurs primarily and early in the disease. In this type of case the appendix is invariably gangrenous. Second, those in which the gangrene of the appendix is more or less localized and there is only one point of perforation. He states that a pathognomonic sign of portal empyema is recurring chills. The presence of chills as an initial symptom in appendicitis is an absolute indication for early operation. Melchior states that if a chill occurs either before or after an appendectomy the cause of which is not erysipelas, pneumonia, tonsilitis, or cholangitis, then one must first think of portal infection. If the chill recurs a diagnosis of pylephlebitis is justifiable, and the patient should be given the advantage of an operative interference. From the above it can be seen that the most prominent, and therefore the most important, objective symptom in pyle-

phlebitis is recurring chills associated with fever and profuse sweats. In addition to these symptoms, there may be slight jaundice, which appears relatively late. The patient may or may not complain of pain in the right upper abdominal quadrant in the region of the liver. Palpation usually reveals a large tender liver. Due to the increased size of the liver, the diaphragm is often forced upward and compresses the lower part of the lung. Because of this, frequently an intra-thoracic lesion is erroneously diagnosed. In addition to these symptoms and signs, there are the usual positive laboratory findings for acute infections within the abdomen.

*Treatment.*—The treatment of pylephlebitis should first be prophylactic. As emphasized by Melchior and others, there is a very high mortality, and because this complication is much more apt to occur in cases of suppurative appendicitis, the best treatment consists of the removal of the infected focus before the process has extended to the radicles of the portal system. The importance of early removal of the appendix has been emphasized by Petren. Of his 18 cases only 6 had been operated upon within the first week of the disease. Thalheimer, Melchior, and others have emphasized that it is essential in those cases of appendicitis which give a history of chills occurring pre-operatively to carefully examine the appendiceal, the ileo-colic, the superior mesenteric vessels, and even the portal vein at the time of operation. If pylephlebitis has occurred and is recognized either at the time of operation or post-operatively, the treatment is surgical. Gerster, in 1903, advised the incision and drainage of the infected and thrombosed vein. Wilms, following the reasoning of Trendelenburg in ligating the ovarian vein in puerperal sepsis, in 1909, advocated the ligation and incision of the veins of the ileo-cecal angle. He reported a case treated successfully in this manner. Sprengel performed the procedure, as advocated by Wilms, several days after an appendectomy. However, the patient died three weeks later of pylephlebitis and liver abscess. In those cases of acute appendicitis in which a thrombosis of the ileo-cecal vein is suspected, Thalheimer advised the division of the meso-appendix without clamps, in order to see whether or not bleeding occurs. Reock is of the opinion that the Wilms operation is not desirable in cases of pylephlebitis, because the process has usually extended beyond the ileo-cecal area. Braun, in 1913, advocated the ligation of the ileo-colic vein in cases of pylephlebitis. He reported two cases so treated successfully. Melchior, in 1928, collected 13 cases in which the Braun procedure had been performed in cases of pylephlebitis. These he divided into 2 groups: First, those in which the veins were attacked at the original operation, when the appendix was removed. There are 8 cases in this group and all were cured. Second, those cases in which the veins were attacked secondarily, after the primary operation. There are 5 cases in this group, there being only one cure and four deaths. This author reports a successful operation, according to the Braun technic, performed in a case of pylephlebitis. Neuhoof produced experimental portal obstruction in animals. Because he produced complete portal obstruction with success, he suggested that



ligation of the portal vein might be performed in cases of suppurative pylephlebitis. He found that it was impossible to completely obstruct the portal vein at one time, as first collateral circulation had to be produced. Beer, following the experimental work of Neuhoﬀ, attempted to ligate the portal vein in a case of pylephlebitis. Before resorting to ligation of the vein, however, an attempt was made to increase the collateral circulation by anastomosing the spermatic vein with a branch of the inferior mesenteric vein. This, however, was unsuccessful. An omentopexy was then performed. Three days later the portal vein was ligated and cholecystostomy performed. Following this, the patient's jaundice became less. He, however, died forty-eight hours later. Colp, in 1926, reported 4 cases of pylephlebitis in which a ligation of the portal vein was performed. All cases, however, ended fatally. From these results it is apparent that in cases with pylephlebitis severe enough to necessitate the ligation of the portal vein such a procedure is of no avail. Once the infection has gained entrance to the liver and there is evidence of hepatic suppuration little can be done unless the infection occurs as a solitary abscess, which is rare. The presence of such an abscess is an indication for incision and drainage.

The following case illustrates the usual clinical course in pylephlebitis:

V. C.—(Fig. 6) ; female; aged ten years. Admitted to Charity Hospital, January 25, 1929; died February 8, 1929. *Chief complaint*.—Pain in the abdomen and fever. Illness began acutely about four weeks ago, when child was taken sick with a rather severe abdominal pain and fever. She had a slight cough at the time of the onset of illness. Since the illness began pains have persisted, and the child has vomited frequently. Child's father was unable to say definitely whether the child has had diarrhoea, but thinks she has had three or four bowel movements daily. Child has had frequent chills since illness began, sometimes two to three chills a day. Appetite has been poor. When admitted she appeared to be ill and very toxic. Is somnolent and uninterested in anything going on about her. Coughs at intervals and expectorates a purulent sputum. Head and thorax negative.

The abdomen was visibly distended. The child complains of epigastric pain and tenderness and rigidity in the epigastrium, as well as the right upper quadrant. Liver and spleen are not palpable. No other areas of tenderness or rigidity.

Extremities: negative. Because of the above symptoms and findings, a provisional diagnosis of typhoid fever was made.

*Laboratory findings*.—Urine—turbid; acid reaction; faint trace of albumin; occasional pus cell. Blood—white blood cells, 1,850,000; red blood cells, 15,000; hæmoglobin, 30 per cent.; neutrophils, 79 per cent. Weidal reaction: negative. No malaria plasmodia found in blood.

The patient was put on typhoid diet and given glucose by rectum, subcutaneously, and intravenously. X-ray of the chest, taken on February 1, showed no evidence of pathology within the thorax. The cardiac shadow is enlarged. Blood culture, taken February 2, is positive for *B. coli*. February 5: An attempt is made to aspirate the right chest. Puncture was done in the eighth interspace in the midaxillary line. A foul smelling pus suggested that the *B. coli* was obtained. This culture was found to be *B. coli*.

X-ray of the chest shows that the right diaphragm is higher than normal, probably the result of a subdiaphragmatic pathology. Patient was seen by a surgical consultant, Doctor Snelling, who suggested the possibility of a subphrenic abscess, and advised transfer to the surgical service.

February 6: Under general anaesthesia resection of twelfth rib on the right side and

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an exploration of the subphrenic space on the right side extraperitoneally. Nothing was found in the subphrenic space. A needle was introduced into the liver, from which a large quantity of foul smelling pus was evacuated. The cavity was opened and drainage tube inserted. Transfusion of 150 cubic centimetres of citrated blood.

The patient's condition remained about the same. There is a considerable discharge from the wound. On February 8, another transfusion of 200 cubic centimetres of blood was given. Patient was supported also by the administration of 10 per cent. glucose intravenously. Patient gradually grew weaker, and died on February 8.

*Autopsy.*—(Doctor Miller.) The peritoneal cavity was found to be free, except for some plastic exudate over the loops of small bowel. There was, however, no evidence of inflammation of the serosa of the small bowel. In the region of the inlet of the pelvis was a small abscess into which the stump of the appendix protruded. The appendix in its distal portion was cystic, and was surrounded by the above-named abscess. The liver contained multiple abscesses, several large ones being located on the right, one of which had been drained surgically. On the left were a large number of smaller abscesses. A hydrop of the gall-bladder was also present, an abscess of the spleen, and there was a pericarditis with effusion.

### CONCLUSIONS

1. Post-operative intra-abdominal complications of appendicitis depend largely upon the extent of the infection. In from 26 per cent. to 100 per cent. of cases of acute appendicitis the infection has extended beyond the appendix when the patient is admitted to the hospital.

2. The usual intra-abdominal complications are peritonitis, ileus, residual abscesses, and pylephlebitis.

3. Peritonitis is the cause of death in from 65 per cent. to 77.5 per cent. of cases dying of appendicitis.

4. Ileus comprises from 6 per cent. to 15 per cent. of all post-operative complications of appendicitis.

5. Residual peritoneal abscesses occur in from 1.8 per cent. to 5.7 per cent. of all cases of acute appendicitis.

6. Abscess in the cul-de-sac of Douglas is the most frequent intra-abdominal residual abscess.

7. Abscesses occur in the right iliac fossa, subphrenic space, and the left side.

8. Pylephlebitis is the most serious complication occurring after appendicitis.

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## PEPTIC ULCER OF MECKEL'S DIVERTICULUM AND ILEUM

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MECKEL'S diverticulum is a structure resulting from the persistence of a portion of the omphalo-mesenteric or vitelline duct. Normally this embryonic structure undergoes complete regression. It may, in rare instances, remain as a completely pervious fistula from the intestine, opening at the umbilicus and discharging intestinal contents. Inversion and prolapse of the ileum may occur through such a fistula. Only the distal portion may fail to involute leaving a mucous-secreting sinus at the navel. If the external orifice also becomes occluded a cyst of the umbilicus results. A mid-portion of the duct may fail to atrophy in which event an enterocystoma is formed. Such enterocysts may be situated entirely in the wall of the terminal ileum. If the entoderm of the duct disappears and its mesodermal covering persists a fibrous cord passing from the ileum to the umbilicus is left, which predisposes to intestinal obstruction by adhesions, angulation, torsion or volvulus of the small bowel.

Commonly, however, only the proximal part of the tract persists leaving a diverticulum arising from the ileum in its terminal two or three feet and communicating freely with its lumen. The pouch is usually 3 to 10 centimetres long, its neck situated at the antimesenteric border of the ileum, and its coats resembling that of the latter in every way. The distal end of the pouch may be free or attached by a fibrous strand to the internal aspect of the navel. At times it develops between the leaves of the mesentery or becomes adherent to the latter.

Such a diverticulum can form the content of a hernial sac, Littré's hernia. If inflammation occurs diverticulitis, peridiverticulitis, abscess and perforative peritonitis may result just as in the case of the vermiform appendix. The accumulation of fecal material or the lodgement of foreign bodies or parasites within its lumen also predispose to infection and its consequences.

The mucosa of these various reported fistulas, cysts and diverticula usually resembled that lining the small intestine. A number of remarkable umbilical anomalies have been recorded, however, in which polyps, cysts and fistulas have secreted a fluid similar to gastric juice. When removed and examined histologically the mucosa bore a correspondingly close resemblance to that of gastric mucosa, usually of the antral type.

*Gastric Mucosa at the Umbilicus.*—In 1881 TILLMANNS<sup>1</sup> saw a boy of thirteen with a bright red umbilical tumor the size of a walnut covered by mucosa. It had been noted after the cord had separated and had gradually increased in size. It was attached by



a thin pedicle. After the boy had eaten, the mucosa would become red and swollen and secrete abundantly. Mechanical stimulation had a similar effect, 2 to 3 cubic centimetres of cloudy tenacious fluid being collected in fifteen minutes. The fresh secretion was strongly acid in reaction and digested fibrin at 39° C. in an acid medium. (Prof. Drechsel.) When the tumor was removed it proved to consist of all layers of the stomach wall, the mucosa resembling that of the pyloric region. (Prof. Weigert.) The skin about the lesion had been eroded by the secretion from the tumor. Tillmanns believed the tumor resulted from a diverticulum of the stomach which presented in a small umbilical hernia and had become constricted off as a result of tying the cord too closely to the body of the infant.

VON ROSER<sup>2</sup> in 1886 saw a boy one and a half years old with a red granular tumor at the umbilicus. It presented a cavity one centimetre in diameter the fistulous opening into which was calloused. The secretion was acid and had macerated the surrounding skin. When excised its mucosa resembled that of the stomach. The peritoneum was not opened. A small residual tract 3 millimetres deep was destroyed with zinc chloride. The author ascribed the anomaly to a diverticulum of the stomach as did Tillmanns. A colleague had previously incised a cyst-like lesion at the navel and applied caustics several times.

SIEGENBEK VAN HEUKELOM<sup>3</sup> reported a case in 1888. A child two and a half years old had a red moist granular tumor at the umbilicus since the cord separated. Its short pedicle was divided, the bleeding being controlled by cautery. The tumor was covered by mucosa showing tubules with lymphadenoid and connective tissue interspersed, and resting upon a muscularis mucosae. The stalk contained smooth muscle, vessels and connective tissue. The mucosal glands contained no goblet cells. In the course of seeking for an explanation the author encountered a fetus with a Meckel's diverticulum the distal part of which was closed off from the main lumen. The mucosa of this portion resembled that of his operative case and of the pyloric mucosa of the same fetus. That of the patent part of the diverticulum was of the intestinal type. In young embryos the entodermal lining of the digestive tract is similar throughout. Differentiation does not occur according to this author until bile and pancreatic secretion enter the intestine. The closed-off portion of the Meckel's diverticulum not coming in contact with these secretions developed in a manner resembling the mucosa of the stomach. The author maintained that the theory of Tillmanns finds no corroboration in available facts.

VON ROSTHORN'S case<sup>4</sup> was reported in 1889. A boy of seven years had an umbilical fistula. After the cord had come away a finger-like projection 4 centimetres long appeared. Then an opening was found from which clear watery fluid flowed continuously. The protrusion gradually receded with the use of caustics, but the opening grew larger. Now a tumor of hazel nut size, red and glistening, presented at the navel. A small orifice admitted a probe for 2 centimetres. The skin about it was reddened. The secretion was mucoid, acid in reaction, and digested fibrin in an acid medium. It was rich in chlorides although free hydrochloric acid was not demonstrated. It amounted to 5 cubic centimetres in 24 hours. The excised funnel-like tract extended down to the peritoneum. At the bottom were glands resembling parotid acini, at the orifice was epidermis, the body of the tract presented a pylorus-like mucosa with deep branching glands.

The author ascribed the structure to the omphalomesenteric duct with early separation from the intestinal tract at a time when the mucosa had not become differentiated. He favored the theory of Van Heukelom and stated that there was no direct proof of the theory propounded by Tillmanns and von Roser.

WEBER<sup>5</sup> saw a boy three years old who had a red growth at the navel since separation of the cord. There was now a fistula 1 centimetre deep. It secreted a watery mucoid fluid, at times with brownish flocculi, to an amount estimated as half a wineglassful a day. There was a colicky pain at midday. Recently a canal-shaped

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wound developed below the fistulous opening, gradually increasing in size, and its edges becoming indurated. This area was excised with the fistula and a cyst into which it led. A thin fibrous cord (remains of the umbilical vein) passed from the cyst to the under surface of the liver. There was no connection with the stomach or intestine. The mucosal lining of the cyst resembled that of the pyloric end of the stomach (Krause).

REICHARD'S case report<sup>6</sup> is undoubtedly that of the same patient as Weber's.

LEXER'S patient<sup>7</sup> was a child of one year. It presented an umbilical fistula with erosion of the skin. The secretion was strongly acid and digested fibrin. A probe entered for 1.5 centimetres only, but at operation another tract led from this point for 6.5 centimetres and entered the small intestine. The distal portion opening on the surface was lined by mucosa resembling that of the pyloric end of the stomach. The proximal portion opening into the intestine was lined by intestinal mucosa. The author assumed an early severance of the outer from the inner portion of the persistent omphalomesenteric duct, thus confirming Siegenbeek's and von Rosthorn's contentions.

STRADA<sup>8</sup> in 1903 reported the case of a woman, twenty years of age, who presented a pedunculated tumor, the size of a walnut, at the umbilicus. The removed specimen showed mucosa of the pyloric type, but some glands of the Lieberkuhn type were also noted. An excellent critical study of the literature of the subject is included in this contribution.

MINELLI<sup>9</sup> in 1905 described an adenoma of the umbilicus with the histology of gastric mucosa and also gave a thorough review of the subject.

DENUCÉ'S<sup>10</sup> patient was a boy twenty-one months of age, with a congenital umbilical fistula. It secreted a colorless or faintly blood-tinged fluid. The skin about it was ulcerated and indurated. A probe could be passed into the fistula for 1.5 centimetres. When the child ate, the flow from the fistula increased at once. Analysis of the secretion yielded free hydrochloric acid, albumin and peptone. Subsequent experiments proved the presence of pepsin and rennet.

At operation the tract was excised and from its base a cord could be seen passing to an intestinal loop. Histologically the mucosa was described as pyloric in type. The illustrations, however, show distinctly both chief and acid cells.

*Comment.*—Thus there was recorded the occurrence at the umbilicus of polypoid tumors, cysts and fistulas usually secreting an acid tenacious fluid, resembling gastric juice in its ability to digest fibrin and causing maceration, erosion or even chronic ulceration of the skin. Swelling and increased secretory activity of the mucosa were noted soon after the ingestion of food and after mechanical stimulation. These anomalous structures when removed and examined presented in whole or in part the histology of gastric mucosa of the type seen in the pyloric and antral regions. The lesions were observed in children, almost always males. Their rapid response to the introduction of food into the stomach is of great interest and suggests a reflex action through the nervous system. At first their origin was ascribed to some previous hernia or diverticulum of the stomach, but later the theory that they were remnants of the omphalomesenteric duct was suggested. As evidence in favor of the latter was Denucé's observation of a fibrous cord attached to an intestinal loop and Lexer's remarkable case of a patent Meckel's diverticulum underlying the umbilical fistula. Siegenbeek ascribed the gastric character of the mucosa to exclusion of part of the vitelline duct before bile and pancreatic secretions began to enter the bowel. Despite the fact that the secretion of the mucosa lining these cysts and fistulas or covering the umbilical polyps was usually acid in reaction, acid forming or oxyntic

cells were not noted. Denucé's illustration, however, shows acid cells. It is plausible to assume that the mucosa was usually of a primitive type, not completely differentiated, yet capable of producing both acid and ferments.

*Gastric Mucosa in Meckel's Diverticulum, Associated with Peptic Ulcer of the Diverticulum or Ileum.*—The theory of Siegenbeek van Heukelom, ascribing the presence of gastric mucosa to an early closing off of part of the vitelline duct, is contradicted by the report of a considerable number of instances subsequently recorded, in which gastric mucosa was found lining Meckel's diverticulum in whole or in part, despite the fact that there was free communication of the interior of the pouch with the lumen of the lower ileum. Schaetz<sup>11</sup> pointed out that islands of heterotopic gastric mucosa occur at two points in the embryonal gastro-intestinal tract, namely the œsophagus and the vitelline duct, the origin of the latter marking the division between the primitive fore and hind gut, and proposed the theory of embryonal transplantation. Later<sup>12</sup> he studied thirty specimens of Meckel's diverticulum by serial section. Of these only 17 or 57 per cent. were free of abnormal elements. Three, or 10 per cent., showed mucosa belonging to higher segments of the small gut, *e.g.*, jejunum, duodenum (*e.g.*, Brunner's glands and pancreatic tissue). Five cases, or 16.6 per cent. presented islands of gastric mucosa. One specimen contained pancreatic tissue, two others pancreatic tissue and gastric mucosa. Another showed a carcinoid, and the last a doubtful type of heterotopia. The incidence of Meckel's diverticulum according to the statistics of various authors ranges from 1 to 4 per cent. According to Stern,<sup>13</sup> Hilgenreiner stated that it occurred once in sixty-one females as against once in thirty-nine males; Doepfner found one in 214 females as against 102 males. Thus it appears to be twice as frequent in males as in females.

The following cases called our attention to the subject of gastric heterotopia in Meckel's diverticulum and led to a review of the literature on the subject.

CASE I.—(Mt. Sinai Hospital No. 293095.) A female infant of fifteen months became suddenly pallid and vomited three days before admission. For two days thereafter she was restless, sleepless, irritable and had temperature of 101° F. On the day of admission foul clotted blood was passed with the stool and she was referred to the hospital by Dr. David Maeth with the diagnosis of Meckel's diverticulum. The patient was pale, with hæmoglobin 55 per cent. General condition was good. A tender mass about 4 centimetres in diameter was felt in the lower abdomen to the right of the mid-line. Per rectum an irregular papillary mass could be felt high up on the right side suggesting an intratestinal growth. Two hours later the rectal examination revealed a sausage-like protrusion with a central depression simulating the cervical os and the possibility of an intussusception made surgical intervention advisable.

Operation July 24, 1928 (P.W.A.) Under ether anæsthesia a right rectus incision was made. A firm thickened inflamed diverticulum was found about 4 centimetres long attached by a fibrous strand to the umbilical region. Beneath this passed a loop of ileum. The mesentery of the terminal ileum was inflamed with areas of gangrenous exudate at the site of adhesions between loops of gut. There was extensive enlargement of the mesenteric lymph nodes. No intussusception was found.

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The diverticulum was freed from the abdominal wall and the adherent loops of gut separated. An ileostomy of the Witzel type was made about six inches above the origin of the diverticulum. A lymph node was removed from the mesentery for examination to exclude lymphosarcoma. Wound closed in layers.

### *Post-operative course.*—

The enterostomy functioned well. A transfusion was given the next day bringing the hæmoglobin up from 35 to 66 per cent. On the second day old blood was passed per rectum. The lymph node was reported as simple hyperplasia. Enterostomy tube removed on eighth day. Wound healed completely on thirteenth day. The mass palpable before operation could no longer be felt. It was, therefore, felt that the process was inflammatory and that the diverticulum should be resected.



FIG. 1.—Microphotograph showing penetrating ulcer of the ileum close to the adjoining gastric mucosa of the Meckel's diverticulum.



FIG. 2.—Microphotograph showing the transition between mucosa of intestinal and gastric types. This area corresponds to that marked X in Fig. 1.

Operation August 10, 1928 (P.W.A.). Under ether anæsthesia the abdomen was reopened through the old scar. The ileocecal junction was identified and the ileum followed proximally to the diverticulum which was found much smaller and less inflamed. It was adherent, however, to the under surface of the mesentery and in separating it from the latter, a small opening in the bowel at the origin of the pouch was found. The diverticulum was now resected with an elliptical portion of the free border of the ileum. The intestine was closed in two layers at right angles to the line of the excision so as to prevent stenosis. The abdomen was closed in layers without drainage. The wound healed well and convalescence was uneventful.

The diverticulum was lined throughout by gastric mucosa showing both chief and acid cells. In the portion of excised ileum just beyond the neck of the pouch was a small chronic penetrating ulcer showing the features commonly found in active peptic ulcer. It

was situated entirely in mucosa of intestinal type, but immediately adjoining the gastric mucosa of the diverticulum. (Figs. 1 and 2.)

It was then recalled by one of us (K) that a similar case had been observed on the pediatric service two years previously.

CASE II.—(Mt. Sinai Hospital No. 262864.) A baby boy of twenty-six months was admitted January 6, 1926, for hæmorrhage from the bowel. The infant had been admitted on four previous occasions for the same complaint. The first admission was at the age of seventeen months. On one admission the hæmoglobin was 30 per cent. and transfusion was necessary. The last admission was a month ago, when a sausage-shaped mass was felt in the right lower quadrant, but disappeared the next day. Gastro-intestinal X-ray studies proved negative.

Two months before the present admission the child suffered abdominal pain in the umbilical area, vomited and passed bright red blood per rectum. The temperature was 101° F. The hæmoglobin was 63 per cent. There was some resistance and tenderness in the right lower quadrant. Chronic or recurring intussusception was suspected.

Operation January 11, 1926.—(Dr. A. V. Moschowitz). A Meckel's diverticulum was found eighteen inches above the ileocecal valve. It was red, inflamed and indurated down to the base. The diverticulum was excised, the stump carbolized and inverted.

On reëxamining the specimen removed, a remarkable similarity to that obtained in Case I was observed. A peptic ulcer was present at the base or neck of the diverticulum at the junction of intestinal and gastric types of mucous membrane.

The cases reported in the literature are summarized in Tables I and II. In the first group are 21 instances in which gastric mucosa was demonstrated in the diverticulum by microscopic examination. The second group consists of 12 cases in which the mucosal histology was not investigated, but in which an ulcer was found upon inspection of the gross specimen. The clinical histories and operative or autopsy findings in the latter series resemble the former in every respect. It therefore seems warranted to consider them together.

*Etiology and Pathology.*—The ages of the patients ranged from nine months to forty-five years, but infants and children comprised three fourths of the cases. The sex incidence was as follows: four females, twenty-eight males, one not specified. It has already been noted that Meckel's diverticulum occurs twice as often in males as in females. Peptic ulcer of the diverticulum or adjoining ileum, however, is seven times more frequent in males. The sex incidence, therefore, approximates that of duodenal ulcer.

The ulcers were usually chronic in type, penetrating or perforating, and resembled the peptic ulcers of the stomach and duodenum. They presented a superficial area of necrotic tissue and exudate, a zone of granulation tissue, and a denser more organized substratum beneath which was the disrupted muscularis and the thickened serosa. One acute punched-out perforated ulcer was observed,—and one which had undergone almost complete healing. Of the thirty-three ulcers seventeen, or almost 50 per cent., had perforated either into the free peritoneal cavity with resulting generalized peritonitis, or had penetrated more slowly with resulting sealing off and local peritonitis. Eroded arteries were noted in five cases. Extensive mesenteric lymphadenopathy was found in three.

It is remarkable that the ulcer was usually situated at the neck of the diverticulum or in the ileum just beyond its neck. In these cases the entire pouch was lined by gastric mucosa, both chief and acid cells being noted

by five of the authors. The analogy to duodenal ulcer and gastrojejunal ulcer is striking. In those instances in which the lesion was located near the tip or in the body of the pouch histologic study showed the ulceration to have occurred in mucosa of intestinal type adjoining a patch of heterotopic gastric mucosa. This finding lends support to those who contend that peptic ulcer in the stomach occurs in islands of heterotopic intestinal mucosa situated in the gastric mucosal lining.

That the heterotopic gastric mucosa in these cases secreted free hydrochloric acid and pepsin may be assumed from the fact that such secretion with attendant irritation and ulceration of the surrounding skin has been amply demonstrated in recorded cases of heterotopic gastric mucosa occurring in umbilical polyps and fistulas.

*Symptomatology and Diagnosis.*—The most common symptom of this disease was the passage of fresh blood and clots per rectum. It was absent in only five of the thirty-three cases reported, and in one of these anæmia was noted. The hæmorrhages were often brisk with long periods of intermission. In Hilgenreiner's patient, who was eighteen years old, blood had been noted in the stools at intervals since childhood. Hübschmann's patient had bleeding following a slight trauma to the abdomen. The infant observed by Callender died thirty-six hours after the onset of hæmorrhage. The man of twenty-eight reported by Mégevaud and Dunant had repeated hæmorrhages since childhood. This presenting symptom led to the diagnosis of intestinal ulcer, tuberculosis, tumor or polyp, duodenal ulcer.

In some cases central abdominal pain preceded the attacks of bleeding, in others it followed the accident. Pain of some sort was noted in twenty-one cases. It was described as cramps, colicky, gnawing. In Mégevaud's patient it was cyclic, relieved by food. In Hübschman's the clinical symptoms suggested peptic ulcer. In Kleinschmidt's case it occurred regularly one and one-half hours after meals. In many its onset was coincidental with the beginning of perforation.

Sudden perforation and the signs of peritonitis were frequent, and these cases were diagnosed as perforative peritonitis, acute appendicitis, ileus. This was the clinical picture in eleven instances, one-third of the total number.

A palpable mass was observed in only one instance beside the two which we have reported. This finding together with the passage of blood per rectum immediately suggested intussusception. The stools lacked the usual admixture of mucus and the symptoms of obstruction were wanting. The differential is extremely difficult, however.

The case reported by A. S. Jackson was diagnosed by the family physician Dr. A. Ketterer, who had seen a similar case ten years previously. The latter had been operated upon by R. H. Jackson. Doctor Maeth diagnosed Meckel's diverticulum in one of our own cases.

Gastro-intestinal X-ray studies were made in six cases without giving any helpful information.

Exploratory laparotomy will usually be the only means of establishing

the diagnosis when, in the presence of suggestive symptoms, other lesions of the gastrointestinal tract have been excluded as the cause of the bleeding by X-ray and sigmoidoscopy.

*Treatment.*—Unexplained cases of repeated intestinal hæmorrhages, in which other lesions have been excluded, should be subjected to exploratory laparotomy on the presumptive diagnosis of peptic ulcer in association with Meckel's diverticulum. If the lesion is found the operation of choice is excision of the diverticulum with enterorrhaphy at right angles to the long

TABLE I  
*Gastric Mucosa in Meckel's diverticulum with peptic ulcer*

Author	Age	Sex	Intestinal Hæmorrhages	Pain	Mass	"Acute Abdomen"	Preoperative Diagnosis	Findings	Result
Hilgenreiner	18	M	+	+	+			Ulcer in M.D. adherent to parietes	Well
Deetz	9	M				+	Perforated ap- pendicitis	Perforated ulcer at base of M.D.	Well
Hubschmann	4½	M	+			+	Peritonitis	Perforated ulcer, marginal	Ceased
Callender	19 mos.		+				(Autopsy)	Ulcer in ileum; open vessel at margin	Ceased
Gramen	10	M		+		+	Appendicitis	Perforated ulcer	Well
Meulengracht	12	M	+	+			(Autopsy)	Ulcer about to perforate	Ceased
Muller	11	M	+	+		+	Peritonitis	Perforated ulcer	Well
Mégevaud and Durant	28	M	+	+			Duodenal ulcer; intestinal tu- mor	Marginal ulcer; eroded artery	Well
Humbert	11 mos.	M	+			+	Peritonitis	Perforated ulcer of M.D.	Ceased
Brasser	15	M	+	+		+	Intestinal polyp	Perforated marginal ulcer	Ceased
Guibal	14	M	+				Intestinal TBC	Chronic penetrating marginal ulcer; eroded vessels	Well
Pascale	41	M	+	+			Ulcer intestin- alis	Ulcer of M.D.	Well
Ulrich	8 mos.	M	+			+	Peritonitis	Perforated M.D.; mesenteric adenitis	Ceased
Abt and Strauss, Case 1	20 mos.	F	+	+			?	Ulcerated M.D.	
Kleinschmidt	15	M	+	+		+	Appendicitis	Perforated ulcer near base	Well
Jackson, A. S.	14	M	+	+			Peptic ulcer of M.D.	Ulcer in M.D.	Well
McCalla	46 mos.	M	+	+			(Autopsy)	Marginal ulcer	Ceased
Hartglass	4	F	+	+		+	Peritonitis	Perforated ulcer, at base	Well
Peterman and See- ger	6	M	+	+			Appendicitis	Penetrating ulcer; many ulcerations in ileum	Well
Aschner and Kare- litz, Case 1	15 mos.	F	+		+		Tumor	Penetrating marginal ulcer; mesenteric adenitis	Well
Do., Case 2	26 mos.	M	+	+	+		Intussusception	Peptic ulcer; diverticulitis	Well

axis of the ileum. The excision may have to include a considerable margin of the wall of the ileum when the ulcer is situated either in that structure or at the neck of the diverticulum. In occasional cases the inflammatory involvement may be so extensive as to necessitate resection of a considerable segment of the ileum with end to end anastomosis. It is probable that this radical procedure can be avoided if an ileostomy is performed proximal to the diverticulum, which may be excised subsequently when the inflammatory process has subsided.

*Summary.*—Heterotopic gastric mucosa has been shown to occur at the umbilicus as a result of anomalous developmental structures arising from the omphalomesenteric duct. Such areas of mucosa have been demonstrated

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to produce a secretion containing free hydrochloric acid and pepsin with irritation, erosion and ulceration of the surrounding skin. The secretion could be excited by the ingestion of food or by local mechanical stimuli. Heterotopic gastric mucosa has also been demonstrated in Meckel's diverticula which have retained their connection with the lumen of the ileum. Chronic ulcers causing pain, hæmorrhage and perforation, and histologically identical with peptic ulcer of the stomach, duodenum and jejunum have been described in Meckel's diverticulum and the ileum (thirty-three cases). In twenty-one of these cases gastric mucosa was demonstrated in the diverticulum. The ulcers occurred in the intestinal type of mucosa adjoining the heterotopic gastric mucosa, being most frequently located at the neck of the

TABLE II  
*Probable peptic ulcer of Meckel's diverticulum, mucosa not investigated*

Author	Age	Sex	Intestinal Hemorrhages	Pain	Mass	"Acute Abdomen"	Preoperative Diagnosis	Findings	Result
Denneke	7	M				+	Appendicitis	Perforated ulcer at base	Ceased
Läwen	23	M		+			Peritonitis	Perforated ulcer; spurting artery	Well
Griffith	19 mos.	M	+	+			(Autopsy)	Uleer of M.D.; peridiverticular abscess; mesenteric adenitis	Ceased
Brentano	21	M				+	Peritonitis	Perforated M.D.	Well
Jackson, R. H.	10	M	+	+			?	Marginal ulcer; eroded artery	Well
Stulz and Wöringer, Case 1	4	M	+	+			Ileus peritonitis	Perforated marginal ulcer	Ceased
Do., Case 2	11 mos.	M	+	+			(Autopsy)	Perforated ulcer at base; abscess	Ceased
Abt and Strauss, Case 2	11 mos.	M	+	+			?	Ulcerations at tip	Well
Moore, Case 1	4	M	+						Well
Do., Case 2	9 mos.	M	+					Uleer at base	Well
Fuss	37	F	+	+				Necrotic bleeding ulcer	Well
Kleinschmidt, Case 2	45	M	+	+				Perforated ulcer	Well

diverticulum which was usually completely lined by gastric mucosa. The occurrence of this type of lesion lends strong support to the theory that the free hydrochloric acid secreted by the gastric mucosa is the most important activating factor in the etiology of peptic ulcer. The cure of these patients by resection of the diverticulum, thus removing the acid secreting gastric type of mucosa, further encourages the efforts of modern surgery to eliminate the factor of free hydrochloric acid in the therapy of peptic ulcer of the stomach, duodenum and jejunum.

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# MULTIPLE CARCINOMATA OF THE LARGE INTESTINE\*

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THERE has been controversy as to whether or not carcinoma of the large intestine is preceded by adenomatous polyp. For those who believe that this relationship does exist, cases of multiple carcinoma of the large intestine can be divided into those which develop on the basis of polyposis and those which do not. The existence of multiple carcinoma of the former type of origin is well known, although cases of multiple carcinoma of the colon have been reported in which it seems that the authors have not recognized the fact that polyposis had preceded the carcinoma. Thus, Phillips and Macbeth reported a case of diffuse adenocarcinoma of the colon in which, judging from the history, a condition of multiple polyposis had existed previously. In the report we are about to make we are not concerned with cases in which multiple polyposis preceded the carcinomas.

The cases which we wish to report are of a type that is not common or well recognized. In all, there was more than one carcinoma of the colon, each of independent origin.

The importance of the investigation is fourfold: (1) The infrequency with which multiple primary malignant lesions of the large intestine are recognized, exclusive of those which are preceded by polyposis, has been mentioned; (2) the possibility of multiplicity of lesions has an important bearing on prognosis; (3) if the possibility of multiplicity of lesions were borne in mind the treatment of so-called benign single polyp might be modified in some cases, and (4) the study might serve as a stimulus to the development of better means of investigation of lesions of the colon.

In attempting to evaluate our own work we have reviewed the reports and opinions of previous investigators. We shall mention a few of them.

Christian Fenger, in 1888, reported a case of double carcinoma of the colon before the Chicago Gynecological Society in which he had performed colostomy for obstructing carcinoma of the colon. The patient's condition was not relieved, and necropsy revealed that there was a carcinoma of the ascending colon and one of the splenic flexure, both large and obstructive. The colostomy had been made between the two obstructive lesions. They were thought to be distinct and separate carcinomas.

In the forty-one years which have elapsed since then, few similar cases have been recorded. However, the occurrence of more than one primary malignant lesion, at the same time or at widely separated intervals, in the same patient, has been frequently noted.

Major, in 1918, reported a case of carcinoma of the face and sarcoma of the stomach and reviewed the literature on multiple malignant lesions

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occurring in the same patient. In this way he noted 196 different combinations of malignant lesions in as many patients, recorded by 196 authors. Major's review of the literature on that subject is the most complete one which we have found. The 196 cases occurred between the years 1889 and 1918. Major noted that with certain kinds of tumors, multiplicity of lesions was prone to occur. In this review of a rather large number of cases not a single instance of more than one tumor in a colon occurred. However, Dowden reported a case in 1917 of a patient who had four lesions of the colon, all within six years. In a series of seven cases of primary malignant lesions in widely separated parts of the body, Ellsworth found two, each with two carcinomas of the colon. He felt that the evidence was clearly in favor of two independent new growths and not of metastasis. Miller reported five cases, in three of which there seemed undoubted development of two or more primary carcinomas of the colon. The three cases included the following: In one case there were three lesions; one of the ileum, one of the cæcum and one of the sigmoid; the first two were annular and the third was polypoid. In the second case a carcinoma of the rectum occurred, and eight years later, a carcinoma of the hepatic flexure. The third case was of two separate annular lesions of the sigmoid of different types. The other two cases might have been examples of recurrence but so much time elapsed between the first and second tumors that they might, also, have been independent growths.

These reports leave little doubt but that multiple primary malignant lesions actually occur not only in the same patient but in the same organ.

One of us (Rankin), in reviewing large numbers of cases, stated that the incidence of multiple carcinoma was very small. In relation to this statement it is recalled that Billroth laid down three postulates which should be fulfilled before multiple carcinomas can be identified as independent lesions: (1) The two growths must show distinct histologic differences which must be so pronounced as to exclude the possibility that they are of the same origin, but in different stages of development; (2) each growth must spring from its parent epithelium, and (3) each growth must be held responsible for its own group of metastatic growths. Attention is also called to Mercanton's addition to these three postulates; that is, "If after removal of two carcinomas the patient remains free from disease, the two growths must have been independent else there should have been other metastasis." It is evident that when growths from intestinal epithelium are concerned, the first of Billroth's postulates cannot well be fulfilled. Moreover, since carcinomatous degeneration of separate intestinal polyps is entirely likely, it seems that this postulate need not be fulfilled in identifying multiple, independent carcinomas of the intestine.

Cabot reported a case in which carcinoma of the cæcum was followed ten years later by carcinoma of the splenic flexure. The appearance of two lesions so widely separated in time, with good health in the interval, should be an indication of two new growths. Ewing, in the chapter on metastasis

in his 1928 edition of "Neoplastic diseases" made this appropriate statement: "We do not speak of recurring uterine myomas, for these are clearly multiple, so why not carcinoma and sarcoma?"

CASE I.—A woman, aged sixty-four years, came to the clinic December 10, 1924, complaining of extreme fatigue and pallor, which had begun about a year before admission. She stated that she always had had a "delicate stomach," had vomited easily, and up to fifteen years before admission she had had diarrhoea every autumn, occasionally with bloody streaking of the stools. Although the diarrhoea had not been a marked feature in the last fifteen years, the stools had always been loose.

Proctoscopic examination revealed a carcinoma measuring 6 by 6 by 8 centimetres, situated in the posterior rectal wall. Röntgenograms of the colon after barium enema disclosed obstruction at the hepatic flexure.

At exploration, December 22, a lymph node was removed from the mesentery which proved to be the site of colloid carcinoma. There was a tumor about 8 centimetres in diameter in the ascending colon. Because of the metastasis, the size of the lesion, and the patient's general condition, ileocolostomy was made.

CASE II.—A man, aged fifty-five years, had come to the clinic in August, 1923, at which time a diagnosis of syphilis of the central nervous system and tabes dorsalis had been made. For these conditions he had had extensive treatment. He returned, April 24, 1925, for reexamination and because he had felt a lump in the abdomen which was movable and which would appear and disappear. He had first noticed this about a year before his second visit. He had consulted numerous physicians about it and all, he said, had advised against exploration. Constipation had increased until a month before admission, since which time he had had loose stools. He had lost twenty-six pounds in weight. He had not seen blood in the stools.

Proctoscopic examination disclosed a carcinoma on the anterior rectal wall. Because of the movable mass in the right lower quadrant of the abdomen roentgenologic examination of the colon was undertaken. This disclosed a filling defect in the caecum.

Exploration was undertaken, May 25, 1925, at which time carcinoma of the caecum, with chronic intussusception of the ascending colon, was found. Right hemicolectomy was performed and lateral anastomosis was made between the lower part of the ileum and the transverse colon. Pathologists reported an adenocarcinoma of the caecum measuring 8 by 6 by 3 centimetres, with serosal and lymphatic involvement. September 21, 1925, the local rectal lesion was excised; this was reported by the pathologist to be adenocarcinoma graded 2. The patient died, July 7, 1926, at his home, apparently from recurrence.

CASE III.—A man, aged sixty-eight years, came to the clinic, July 26, 1927, complaining of rectal bleeding of one and a half year's duration. He had lost about 5 pounds in weight. Proctoscopic examination revealed a normal rectal mucosa for 24 centimetres. Röntgenogram after barium enema disclosed a filling defect in the sigmoid portion of the colon.

Exploration, August 5, 1927, revealed a malignant polyp of the descending colon, at which time the first stage of the Mikulicz operation was done. Subsequently, the second stage was done. Pathologists found two distinct malignant lesions, one of which measured 5 by 3 by 1 centimetres, and an adenocarcinoma graded 2, without lymphatic involvement. The second tumor, 5 centimetres above the first, was an adenocarcinoma graded 1 and measured 5 centimetres in diameter.

CASE IV.—A man, aged fifty-three years, came to the clinic in May, 1922, complaining of pain and distress across the lower part of the abdomen, of eighteen months' duration, and coming at intervals of three to seven days. In several of the attacks there had been emesis, but never fever. The family history was noteworthy. The mother had died of what was said to have been carcinoma of the liver. One brother had died

of intestinal obstruction and one brother had a tumor of the transverse colon. The patient had undergone appendectomy elsewhere than at the clinic and adhesions about the colon had been dissected away. About three weeks after the operation, the attacks had recurred. In September, 1920, he had weighed 210 pounds; in May, 1921, 140 pounds. Later on, his weight had increased to 196 pounds. On admission to the clinic he weighed 165 pounds. He never had had diarrhoea; there never had been gross blood in the stools and constipation had been present all his life.

General examination disclosed the presence of a movable mass in the lower right quadrant of the abdomen. A röntgenogram of the colon disclosed a filling defect in the cæcum and proximal part of the transverse colon (Fig. 1). The concentration of hæmoglobin was 60 per cent.; erythrocytes numbered 4,170,000 and leucocytes 11,700 in each cubic millimetre of blood. Exploration was undertaken and two carcinomas were found, one of the cæcum, and one of the proximal portion of the transverse colon, for which right end-to-side anastomosis and right resection were done. The pathologist



FIG. 1 —Case IV. Filling defect in cæcum and proximal part of transverse colon.



FIG. 2 —Case IV. Later filling defect in sigmoid portion of colon.

reported carcinoma of the cæcum, 5 centimetres in diameter, and carcinoma of the transverse colon, 1 centimetre in diameter, with lymphatic involvement.

The patient returned in October, 1928, with the statement that constipation had continued since the operation, that it had become much worse during the last year, and that it had been extremely difficult for him to move his bowels three months prior to readmission. For six months there had been pain and aching in the lower part of the abdomen, which was worse when he stood erect. Often, it was of the tearing type. During the three months prior to his second admission he had been taking a considerable quantity of laxatives, and three weeks prior to admission, very severe, continuous pain had developed in the right lumbar region, with intermittent attacks of greater severity. He had lost thirty-five pounds in five months prior to admission. Examination revealed a mass in the left lower quadrant of the abdomen. A röntgenogram of the colon disclosed two filling defects, one in the sigmoid, and one in the distal part of the transverse colon (Fig. 2). Exploration was undertaken, October 18, and two carcinomas, one of the sigmoid, and one of the transverse colon, were found. The one in the transverse colon, near the splenic flexure, was polypoid and mobile. The one in the sigmoid, however, was fixed to the tissue about it and to the pelvic rim, and had in it several loops of small bowel, so that it was clearly inoperable. Colostomy of the transverse

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colon was made. A third brother of this patient presented himself at the clinic in the summer of 1929 with carcinoma of the transverse colon.

CASE V.—A man, aged fifty-three years, came to the clinic, in June, 1920, stating that he had been well until two years prior to his admission, since which time he had had epigastric distress. The distress had come on every day several hours after eating. There had been progressive loss of strength and progressive pallor, and he had noticed a mass in the right lower quadrant of the abdomen. He had lost thirty-three pounds in weight. The concentration of hæmoglobin in the blood, on admission, was 21 per cent. with 2,690,000 erythrocytes and 13,200 leucocytes for each cubic millimetre of blood. There was a freely movable mass in the abdomen, to the right of the umbilicus. After several transfusions, exploration was undertaken and a carcinoma of the ileocecal coil was found. Resection of the right half of the colon and end-to-end anastomosis was done. The pathologist reported a carcinoma of the ascending colon which measured 10 by 6 by 2.5 centimetres without lymphatic involvement.



FIG. 3.—Case VI. Filling defect of ascending colon in 1920.



FIG. 4.—Case VI. Microscopic structure of the carcinoma resected in 1920.

The patient returned for observation in November, 1924, without any complaints and nothing unusual was found on general examination. He returned also in October, 1926, without any complaints. A röntgenogram of the colon at that time disclosed some spasm in the descending colon. In October, 1927, he was brought to the hospital with partial intestinal obstruction. He stated that a week prior to admission there had been some difficulty in moving the bowels but that only twenty-four hours before admission there had been the severe gripping pains, abdominal distention, and difficulty in moving the bowels. After the obstruction had been reduced, röntgenologic examination of the colon was undertaken and a filling defect of the upper part of the sigmoid was noted. Exploration was done, and a ring type of carcinoma of the sigmoid was found, for which a Mikulicz type of operation was done. Metastasis was not found in the abdomen. The pathologist reported adenocarcinoma, 5 by 5 by 1 centimetres, without lymphatic involvement.

When the patient was last examined, in September, 1929, he was the picture of health. There was no evidence of recurrence and the blood count was normal. The patient weighed 15 pounds more than his usual normal weight.

CASE VI.—A woman, aged thirty-seven years, came to the clinic, March 9, 1920, stating that following a cold in November, 1919, a dull pain had developed in the

lower right quadrant of the abdomen. Since that time, there had been some distress from gas and an intermittent fever with a temperature often as high as  $102^{\circ}$  F. The fever had lasted for a week and this had been followed by a week of freedom from it. Constipation had been present for ten years, but there never had been diarrhoea or gross blood in the stools. In February, 1920, röntgenograms of the colon made elsewhere than at the clinic had suggested obstruction in the ascending colon. A cystoscopic examination at this time gave negative results. During the three months prior to admission to the clinic, she had noticed considerable gurgling of gas in the right side of the abdomen which seemed to come to a certain spot and stop. She had lost nineteen pounds in weight.

Examination at the clinic revealed a movable, rather firm mass in the right side of the abdomen. In the röntgenograms, a filling defect of the ascending colon was seen (Fig. 3). The concentration of hæmoglobin at this time was 69 per cent.; erythrocytes numbered 4,150,000 and leucocytes 11,800 in each cubic millimetre of blood. Exploration,



FIG. 5.—Case VI. Filling defect in sigmoid portion of colon in 1926



FIG. 6.—Case VI. Microscopic structure of the carcinoma resected in 1926.

March 13, revealed a carcinoma of the ascending colon and hepatic flexure for which resection of the right half of the colon and end-to-end anastomosis were done. The surgeon expressed the prognosis as a "50 per cent. chance of a five-year cure." The microscopic appearance of this tumor is shown in Fig. 4.

The patient returned for observation in October, 1922. She had gained thirty-four pounds in weight. The concentration of hæmoglobin at this time was 75 per cent. and erythrocytes numbered 4,210,000 in each cubic millimetre of blood. Röntgenograms of the stomach and colon gave negative results and there was no evidence of recurrence of the malignant condition.

On the patient's next visit in August, 1926, she stated that there had been some rectal bleeding since 1922. Abdominal gas and discomfort had started in 1925 and there had been much bloating three months prior to admission. She then had had the first attack of severe cramp in the lower part of the abdomen, which had been relieved by passage of gas. This had recurred at frequent intervals. She had lost twenty-two pounds in weight and a mass low in the left side of the abdomen was felt on pelvic examination. The concentration of hæmoglobin at this time was 54 per cent., and

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erythrocytes numbered 3,570,000 in each cubic millimetre of blood. The röntgenogram of the colon disclosed a filling defect in the sigmoid (Fig. 5).

Exploration, September 3, revealed a carcinoma of the sigmoid for which a first and second stage Mikulicz operation was done. The pathologist reported colloid adenocarcinoma graded 1 (Fig. 6). The final stage of the Mikulicz operation was performed November 11.

The patient returned for examination in April, 1929. She stated that she had been very well since the operation of 1926 but that there had been some distress in the region of the scar, and during the week prior to her admission there had been generalized abdominal cramps. She had had intermittent bloating, abdominal distention and progressive difficulty in movement of the bowels for the four months prior to admission. Also, there had been much abdominal gurgling, and she described visible peristalsis running from the right side of the abdomen toward the umbilicus.

Examination disclosed visible peristaltic waves, and a movable mass in the region of the splenic flexure above the scar of the Mikulicz operation. The mass moved with respiration. Röntgenograms, April 11, showed an extensive filling defect of the splenic flexure of the colon (Fig. 7). The concentration of hæmoglobin at this time was estimated at 55 per cent.; erythrocytes numbered 3,810,000 and leucocytes 14,300 in each cubic millimetre of blood.

Exploration, April 19, revealed a carcinoma, for which resection of the left half of the transverse colon, splenic flexure and descending colon

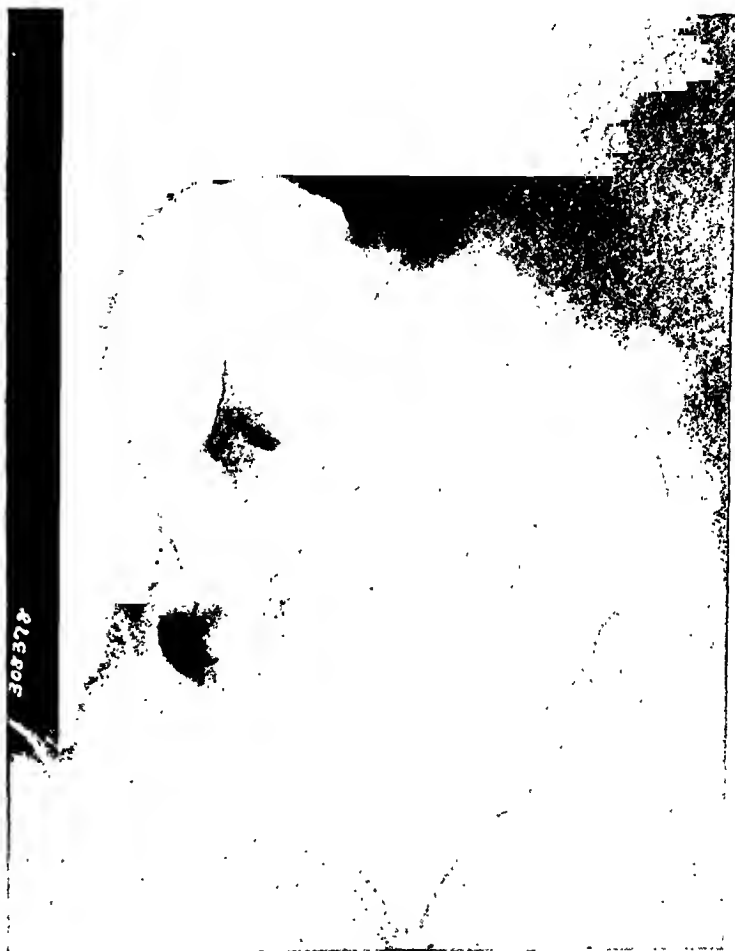


FIG. 7.—Case VI. Filling defect in splenic flexure of colon in 1929.

was made and colostomy was done. The pathologist reported carcinoma, 5 centimetres in diameter, with lymphatic involvement (Fig. 8). At the visits, in 1920, 1926, and 1929, proctoscopic examination gave negative results.

The patient returned, October 14, 1929, stating that for three months after the last operation she had steadily improved in health but that during the last three months she had failed progressively, had been weaker and had felt a tumor in the lower part of the abdomen. At this time the concentration of hæmoglobin was 40 per cent. The patient looked ill and there was a huge mass in the lower part of the right side of the abdomen, very mobile and globular. A probable diagnosis of recurrent, metastatic carcinoma was made, and because of the mobility of the region, exploration was undertaken.

October 21, subtotal abdominal hysterectomy was done for a huge sarcoma of the uterus. The pathologist reported degenerating sarcoma of the uterus measuring 15



by 14 by 13 centimetres, with adnexa, weighing 780 grams. The patient recovered and was living and doing fairly well, December 1, 1929.

CASE VII.—A man, aged fifty-six years, came to the clinic, May 19, 1926, complaining of increasing constipation during the year prior to his admission. Blood in the stools, and brownish rectal discharge had begun about five months before and had increased in quantity. The stools had become smaller and narrower. He had lost thirty-five pounds in weight.

Proctoscopic examination revealed a carcinoma measuring 8 by 8 centimetres. Exploration was undertaken, May 27, 1926, and two distinct carcinomas, one of the sigmoid and one of the rectum, were found. The sigmoid was brought out by a first and second stage Mikulicz operation and the pathologist reported a carcinoma measuring 3.5 by 2.5 by 0.5 centimetres, with lymphatic involvement, and involvement of 7 centimetres of the sigmoid. June 22, 1926, posterior resection of the rectum was undertaken; an adenocarcinoma graded 3 measuring 6 by 5 by 1 centimetres with extension into perirectal tissue, was reported by the pathologist. Radium was used later.



FIG 8—Case VI. Microscopic structure of carcinoma resected in 1929

CASE VIII.—A man, aged sixty-two years, came to the clinic, March 5, 1928, stating that he had had a rectal growth for about eight or ten years, and had seen blood in the stools for about one and a half years.

Proctoscopic examination revealed two malignant lesions, one rectal and one sigmoidal, separated by 7 centimetres of normal bowel. The rectal lesion was large and involved the middle portion of the rectum; the lower margin was 6 centimetres above the anus. The sigmoidal lesion was smaller.

March 12, 1928, colostomy was done, and March 26, abdomino-perineal resection of the sigmoid and rectum was performed, at which time the pathologists reported an adenopolypoid carcinoma of the sigmoid and an adenocarcinoma of the rectum graded 2.

CASE IX.—A physician, aged forty-nine years, came to the clinic in June, 1928, complaining of rectal soreness, diarrhoea of ten months duration, with seven to eleven stools in twenty-four hours, shooting pains, and loss of weight of twelve pounds. Up to a year before, his bowels had been perfectly normal. Specimens of the rectal lesions had been removed elsewhere and a diagnosis of adenocarcinoma had been made.

Proctoscopic examination revealed a polyp on the anterior wall and one on the posterior rectal wall. These were fulgurated.

CASE X.—A woman, aged fifty-four years, came to the clinic January 30, 1928, complaining of rectal trouble which had been present for twelve years, with occasional passage of blood. Six weeks before admission she had had a constant burning pain in the rectum. She had noted loss of weight of ten pounds.

Proctoscopic examination revealed two lesions: one on the anterior anorectal margin, which was an indurated ulcer with a sloughing base, another 3 centimetres above the anus, in the posterior wall, which suggested a sloughing adenoma about 1.5 centimetres in diameter. A specimen removed disclosed an adenocarcinoma graded 3.

Colostomy was performed, February 3. Intra-abdominal metastasis was not found. February 25, posterior resection of the rectum was done, and two adenocarcinomas

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graded 4 were found; one measured 4 by 4 by 2 centimetres, and the other 2 by 1 by 1.5 centimetres. They were 4 centimetres apart and there was lymphatic involvement.

The patient returned, July 25, 1928, with recurrence at the site of resection. Radium was used.

CASE XI.—A woman, aged sixty-five years, came to the clinic in June, 1928. She gave a history of bleeding from the rectum with her bowel movements for three months, with urgency and a frequent desire to have bowel movements. Nevertheless, there had been increasing difficulty in moving the bowels.

General examination revealed nothing of note except a firm, hard, rectal lesion. Proctoscopic examination disclosed two distinct lesions. The smaller one was in the dentate margin, about 5 centimetres in diameter; the larger one was in the left rectal wall, beginning about 8 centimetres above the anus, and was 9 centimetres long by 6 centimetres wide. Exploration, June 8, revealed a carcinoma of the rectum that was inoperable, because of evidence of metastasis to the liver. Colostomy was performed.

CASE XII.—A man, aged forty-five years, came to the clinic in March, 1929, complaining of increased constipation for three years. He had had a bowel movement about once a week during the last year, until, three months before admission, he had begun to have six to eight stools a day with urgency and much mucus, and the stools had been streaked with blood. He had lost fifteen pounds in weight.

Except for the moderately firm growth in the posterior wall of the rectum, nothing of note was discovered in the general examination. Proctoscopic examination revealed a malignant lesion beginning about 4 centimetres above the anus.

Combined abdomino-perineal resection was done, March 26, and a permanent colostomy opening was made because of a carcinoma of the rectum and one of the sigmoid. The pathologist reported three distinct growths, the largest of which measured 10 by 9 by 4 centimetres. Distant from this 5.5 centimetres was another growth 6 centimetres in diameter and 3.5 centimetres from this a third which measured 6 by 5 by 2 centimetres. The condition was one of papillary adenocarcinoma without lymphatic involvement.

CASE XIII.—A man, aged forty-four years, came to the clinic in January, 1929, complaining of having pain in the lower part of the abdomen radiating to the lumbosacral region, and of about five months' duration. Herniotomy had been made elsewhere than at the clinic in October, 1928, without relief. Besides the pain, there had been diarrhoea and bleeding, with movement of the bowels during the five months, and much tenesmus with urgency. He had noted blood in his stools for twenty years and had always had loose stools. He had lost twenty pounds in weight in five months.

Except for a mass in the rectum and the scar of recent herniotomy, there was nothing noteworthy found on general examination. On the posterior rectal wall could be felt a pedunculated mass, and high on the anterior rectal wall a fixed mass. A roentgenogram of the colon disclosed a filling defect of the sigmoid. Exploration revealed multiple malignant polyps of the rectum and sigmoid; the largest one was obstructive, and for this a Mikulicz colostomy was done. The pathologist reported an adenocarcinoma measuring 5 by 4 by 2.5 centimetres.

CASE XIV.—A man, aged sixty-eight years, came to the clinic because of rectal trouble of a year's duration. There had been bleeding, with hard stools. Hæmorrhoidectomy had been done about ten months before admission. Following this there had been a more or less constant desire to go to stool, with urgency, but often only gas, mucopurulent material, and blood had been passed. He also had mild diabetes. He had lost fourteen pounds in weight.

Moderate arteriosclerosis was found to exist. Otherwise, general examination revealed nothing of note except two immovable masses. One mass was on the anterior wall, just above the anus, and the other at the juncture of the rectum and sigmoid, and was much larger.

Exploration, January 18, revealed a malignant condition of the rectosigmoid, that

was inoperable because of metastasis to the liver. Biopsy disclosed adenocarcinoma graded 2.

CASE XV.—A woman, aged forty-six years, came to the clinic in June, 1929, because of rather constant pain in the left lower part of the abdomen. The pain was increased by eating and drinking, was accompanied by much bloating, and it radiated to the left hip and the vagina. It was of many years' duration. Occasionally for many years mucus and blood had been noted in the stools.

Proctoscopic examination revealed a malignant lesion high in the sigmoid. Resection for obstructing carcinoma of the sigmoid was done, June 24, 1929. The pathologist reported adenocarcinoma graded 2, 3 by 3 by 1 centimetres, with lymphatic involvement. Distant from this 4 centimetres was a carcinomatous polyp, 1 centimetre in diameter. The latter was an adenocarcinoma graded 1.

CASE XVI.—A man, aged fifty-six years, came to the clinic in July, 1929, stating that he had a growth in the rectum. For a year he had noticed in the stools mucus and pus which had been said to be due to "colitis," and he had been having about three bowel movements a day. Three months before admission he had seen the first blood in his stools and this had continued off and on, and until his admission. A month before admission he had been examined elsewhere and a diagnosis of adenocarcinoma had been made.

On admission, except for the fact that his weight was eleven pounds less than what he claimed to be normal for him and except for a benign type of hypertension, general examination gave essentially negative results. However, proctoscopic examination revealed a malignant lesion involving the right half of the rectosigmoid. Below this there were two large polyps, one about 6 centimetres above the dentate margin and the other 30 centimetres above the anus.

July 15, permanent colostomy was performed, and on August 3, posterior resection of the rectum for carcinoma. The pathologist reported adenocarcinoma graded 2, measuring 4 centimetres, 4 by 4 by 1.5 centimetres, and two carcinomatous polyps.

#### COMMENT

Multiple primary malignant lesions in various tissues of one person, and occurring at the same or widely separated intervals of time, have been frequently recorded. Similar malignant tumors, occurring in the same organ at the same or different times, have rarely been described. Carcinomas of a hollow viscus that are essentially alike or closely related and that are distinctly separate primary malignant lesions are rare, but probably they are not as infrequent as formerly has been supposed. We feel that in each of these cases we were dealing with two or more distinct, primary, malignant lesions. That this fact has a distinct bearing on treatment and prognosis needs no further emphasis.

The question of the origin of these tumors and the probable reasons for their occurrence offers much food for speculation. The frequent occurrence of single adenomatous polyps throughout widely disseminated portions of the colon has been discovered at necropsy, has been revealed by röntgenograms after barium enemas, has been disclosed by proctoscopic search for disease, or has been suspected because of unexplained rectal bleeding. Polyps should be considered omens of possible future malignant disease of the large intestine.

It is not known, nor is it fair to predict, whether or not a given polyp will become malignant. However, careful investigation of every case of

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rectal bleeding, and removal of the cause of such bleeding, offers much hope for early recognition of malignant disease of the colon and its subsequent eradication. Multiplicity of such lesions is probably much more common than is now suspected.

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# TRANSACTIONS

OF THE

## NEW YORK SURGICAL SOCIETY

STATED MEETING HELD JANUARY 22, 1930

The President, DR. EDWIN BEER, in the Chair

### OSTEOMYELITIS OF SPINE

DR. WILLIAM B. PARSONS, JR., presented a man who was forty years old in December, 1927, when he came to the Presbyterian Hospital complaining of soreness in his pelvic bones which had been felt for one week. His family history was apparently unimportant, and his previous history was singularly free from acute and chronic diseases. Several years ago he weighed 180 pounds, but on admission and since, in the follow-up clinic, his weight has been in the neighborhood of 165 pounds.

About five months before admission, he went to bed feeling well, but woke up with severe pain in the perinæum. The following day both testes were swollen, but following rest and the application of an ice-bag they returned to normal size in two days, and the pain had disappeared from the perinæum. Pain, however, appeared in the kidney region and again lasted a few days, to disappear and move up to the thoracic region of the back. Although his temperature was never above 100° and he had no cough, no sputum and no painful respiration, a diagnosis of "pleurisy" and "pneumonia" was made. He was kept in bed for four weeks and improved considerably. He was then sitting around in the house, convalescing, for about two weeks, when there suddenly developed terrific pain in the left side, principally in the region of the hip. He was told that this was "neuritis." This pain recurred from time to time until admission to the hospital. Three months before admission, a painful swelling appeared in the region of the anterior superior spine. Soon afterwards the "neuritis" pains became very severe, and ran through the pelvis from side to side.

He went to a hospital in New Jersey where he was two weeks under observation. X-rays from head to foot were reported negative, as were blood counts, urine analysis and cystoscopy. He was then operated on for pus in the left iliac crest. The bone was scraped and the wound was packed. This was eight weeks before admission, and the wound was still granulating. He was in bed five weeks after the operation, and apparently had another attack of pneumonia. He was at home for two weeks and was fairly well, except for pain in the lower part of the spine. The week before admission, pain and soreness began in the pubis and in the ischial tuberosities, particularly on the left side, so that walking, sitting and standing were extremely difficult, and he was not very comfortable lying in bed. An occasional evening rise in temperature had been noticed, but no difficulty was experienced in defecation or urination.

On physical examination the significant findings were a markedly enlarged liver, a palpable spleen, a rigid but, interestingly enough, non-tender spine. There was, however, marked resistance to forcible extension of the left thigh. There was tenderness over the left ischial tuberosity which was quite definite. The symphysis pubis was moderately tender. Over the left iliac crest there was a nearly healed operative scar. Urine was clear; blood-pressure was normal; Wassermann was negative; liver function test was normal; there was slight concentration of the blood, with 6,000,000 red cells having a hæmoglobin of 95 per cent. and 11,800 white cells with 76 per cent. polymorphonuclear leucocytes; the rectal examination was negative.

## OSTEOMYELITIS OF SPINE

X-ray examination on admission showed slight thickening of the apical pleura and slight exaggeration of the bronchial shadows in the right lower lobe. No shadows representing tuberculous infiltration were seen. A small linear shadow was seen lateral to the anterior part of the crest of the left ilium. A destructive process was noted in the left ischial tuberosity. Stereos of the lower lumbar vertebrae and a flat lateral view showed evidence of a pathological process involving the adjacent margins of the fourth and fifth lumbar and the intervertebral disc. The latter was definitely narrowed but not obliterated. The adjacent margins of the vertebrae appeared to be fairly sharply defined and straight, and possibly slightly increased in density as compared with the upper margin of the fourth lumbar for example. The left side of the upper margin of the fifth was beveled off, as was, to a less extent, the adjacent margin of the fourth. The right side of the lower margin of the fourth showed this sharply defined bevel more distinctly. There was nothing to suggest a pari-vertebral abscess. In the lateral position there seemed to be a slight but definite increase in density on either side of the narrowed intervertebral disc. Dr. Ross Golden felt that this was against tuberculosis, but there was no evidence of new bone formation which ought to be present to justify completely the interpretation of this as being due to a non-tuberculous lesion. He was seen by several orthopaedic consultants who agreed that it was probably tuberculosis, but they differed as to the advisability of doing a fusion operation on the spine.

Tenderness over the left tuberosity of the ischium increased, and the patient's temperature, which had been from 99° to 100° during the first week in the hospital, went up in the next week to range around 101° to 102°, so the left tuberosity was explored. A zone of œdema over the bone was found, but no pus was encountered. The tuberosity of the ischium was softened and definitely crumbly. The bone was curetted and packed with iodoform gauze. Cultures from the œdema fluid and the œdematous tissue and the bone all grew out *B. acidilacti*. Microscopical examination of the bone and soft tissue was reported as follows:

"The specimen said to be curettings from the ischium shows on section numerous bony trabeculae which appear to be proliferating, for along their margins are seen numerous osteoblasts. Between the trabeculae is a marked infiltration with round cells, plasma cells and large phagocytic mononuclear cells, the latter contain much brownish pigment. A very few polymorphonuclears are also found here. Occasional hæmorrhagic areas are seen. A portion of soft tissue removed with the curettings shows on section a mass of slightly œdematous connective tissue in which there is a large infiltration with round plasma, large mononuclears and also numerous polymorphonuclears. In one area the tissue is undergoing necrosis. *Diagnosis*—*Chronic suppurative osteomyelitis of ischium.*" Doctor Stout made a footnote to the effect that—"It is evident that this is an infection with an unusual organism as the reaction to it is unusual."

X-rays taken one and two months after operation seemed to show a little more destruction of the fourth lumbar with a slight broadening of the bevel and further narrowing of the intervertebral disc. Films of the pelvis showed an extension in the process in the ischium along the surface of the bone from the acetabulum nearly to the pubic symphysis.

The operative wound was healed in thirty-six days. He was given ultraviolet light, was allowed up on the forty-third day, and went home on the seventy-fifth day after operation, having been walking for about two weeks.

He improved gradually but steadily at home. By six months, he could do about half hour's work. The lower spine was stiff but straight, and was not tender. The liver was still three fingers below the costal margin. By nine months, after a strenuous summer vacation, he was in excellent condition and was doing his full work. At fifteen months, after landing hard on both heels, a swelling appeared over the left ischial tuberosity, and the old wound discharged slightly for a while. Last December, twenty-four months after operation, he was in excellent health. The nature of his work requires a sixteen-hour day once in two weeks, and then he has a tired feeling in his back, associated

with general fatigue. The lumbar spine was nearly rigid but not tender. The liver was still palpable. X-rays taken during the follow-up showed a gradual narrowing of the intervertebral disc and change in the architecture of the bone, indicating subsidence of the process but with increase in the beveling, and at two years almost complete loss of the intervertebral disc and definite evidence of ankylosis.

This case is presented as a somewhat unusual example of a comparatively infrequent condition. Wilensky, in the *ANNALS OF SURGERY* for April and May, 1929, reviewed the subject of osteomyelitis of the spine. In the vast majority of the cases, acute osteomyelitis is a disease of adolescence, usually being confined to the dorsal or lumbar spine. Most of the cases associated with the usual pyogenic organisms were followed by abscess formation, and in his article Wilensky discusses the symptomatology and course and finally the formation of abscesses. Since 1905, the mortality from the pyogenic type has ranged from 35 per cent. to 45 per cent., with an interesting difference in the cases quoted by Donati, who found lesions of the arch with a mortality of 33 per cent., but a 78 per cent. mortality for lesions of the body.

The bacteriology of the spinal disease in this case was not subject to proof, and the organism causing the iliac crest infection is not known. The organism involved in the ischial tuberosity disease was of low virulence and associated with a corresponding cellular reaction and no pus formation. One has a right to assume that the other bone lesions were similar in nature, and that probably the lesion in the ischial tuberosity would have subsided without incision and drainage.

#### SUBUNGUAL MELANO-CARCINOMA OF THUMB

DR. WILLIAM B. PARSONS, JR., said that in the November, 1927, *Archives of Surgery*, N. A. Womack, of St. Louis, reported on four cases of subungual melanoma or Hutchinson's melanotic whitlow, bringing the total of reported cases up to twenty-five. Since then, no cases have been reported.

The origin of these neoplasms has been variously ascribed to epithelial, mesothelial and endothelial cell origin, but in as much as melanin seems to be only of epithelial origin, the weight of evidence, as stated by Bruno Bloch, would favor their origin as epithelial.

In the reported cases, trauma was particularly frequent in the lesions in which pigmentation was not an early feature. In the cases without trauma, a discoloration in the nail-bed was usually the first thing noted, followed by ulceration and usually a secondary infection. Metastases are usually found in the anticubital and axillary spaces, although in Boyer's case the initial lesion existed as a pigmented area for thirty years.

Of the 25 cases reported by Womack, 9 were not followed; 3 were dead at unknown intervals; 7 had recurrence in from two to eight years—of these, 4 were dead; the remaining 6 had no recurrence (one at two months, one at six months, one at one year, two at two years, one at four years).

He now presented as an example of the condition in question a woman, forty-seven years of age, who had presented herself at the hospital in December, 1925, at the age of forty-three. Ten years before, she had pleurisy with hæmoptysis, and was sent to Otisville for three months, but was not put to bed, and her cough had ceased before her return to New York. Health otherwise had been excellent. Approximately eight years before, she noticed black stripes on or under the nail of the left thumb. Gradually pieces of the nail broke off, and for the last two years there had been no thumb nail present. The nail-bed bled very easily on the slightest trauma. There had been a gradual enlargement of the end of the thumb for the twelve months before admission.

## SUBUNGUAL MELANO-CARCINOMA OF THUMB

On admission, the positive findings were a blood-pressure of 155/110; a few crackles at the right apex, but a negative X-ray of the lung field. Locally, the distal portion of the left thumb was moderately swollen; the nail was absent, and the nail-bed was represented by a mass of exuberant granulation tissue. X-ray examination of the thumb showed no evidence of bone sarcoma or osteomyelitis. No enlargement of the lymph glands could be made out.

A biopsy was done, a procedure of distinctly doubtful advisability. This showed a mass of connective tissue infiltrated with lymphocytes and polymorphonuclear leucocytes, with numerous strands or groups of large cells with hyperchromatic nuclei, many of which contained brown granular pigment, negative for iron.

On Doctor Stout's suggestion, the thumb was amputated, and the axillary lymph glands were removed. The microscopical examination was reported as follows:

"Section consists of a mass of tumor cells with connective tissue stroma and bordered by a bit of skin. The tumor cells are in cord-like arrangement penetrating all parts of the section in no definite manner. The nuclei are rather long hyperchromatic and of various sizes and shapes. There are a few mitoses. Collections of round cells are present in the stroma with occasional polymorphonuclear leucocyte and plasma cells. The axillary lymph glands, 10 in all, are free from metastases. The germinal centers and reticulo endothelial system in general are very prominent. *Diagnosis—Melano-carcinoma of thumb.*"

Five days after operation a moderately severe hæmolytic staphylococcus aureus infection occurred. This, however, progressed satisfactorily, and was at all times localized to the amputation stump.

The follow-up findings have been of considerable interest. The patient was most faithful, and returned many times to the follow-up clinic and at frequent intervals from March, 1926, until December, 1928, for radiotherapy, which was given to the left upper chest, sternal region, left antecubital fossa and both hands. The amputation stump was very slow in healing, but eventually repair was completed.

At fourteen months after operation, she complained of a painful stump, and on the thumb, index and middle fingers of the right hand dark streaks were noted, which she stated were similar to the area on the left thumb prior to the appearance of the tumor. Following radiotherapy there seemed to be some improvement. At eighteen months everything was satisfactory. Similar findings at twenty-four months; but at thirty-one months a small dark spot 3 millimetres in diameter was noted between the knuckles of the index and middle fingers of the left hand. Examination of this showed spindle-shaped cells growing irregularly between connective tissue bundles, with both intra- and extra-cellular pigment in the new growth. This pigment again did not show the reaction for iron. Three months later another small bluish spot was noted in this region, and on the right hand nearly all of the middle finger nail presented bluish streaks. Radiotherapy was continued, and in two months streaks were visible on the other nails of the left hand. By thirty-eight months the right index finger was better, the right middle finger was worse. The left index showed more pigmentation and the left middle finger less, a transverse line across this nail having completely disappeared. At this time she was also complaining of puffiness of the hands and some pain in all the joints. An X-ray at this time showed slight hypertrophic changes about the margins of all of the phalanges of both hands and of the carpus of the left. At forty-one and forty-six months, after operation, no new evidence of recurrence was noted, the finger nail streaks were in general better, and the second blue spot had disappeared.

This patient is now four years and one month after the operation. Minor recurrence was proved in the skin, and a similar condition was suspected in all the subungual spaces. Frequent radiotherapy had apparently been of great importance in controlling the condition.

The reporter inquired if any member of the Society had had any experience in



grafting bone into a thumb amputation stump. If this patient had even two centimetres of greater bone length, she would have a longer stump that would help greatly in the grasp of this hand.

This patient was shown as an example of a rare condition with a longer follow-up than most of the recorded cases. If a biopsy is to be done in this type of case, it should certainly be done as a frozen section. Amputation and dissection of the axillary lymph glands, followed by intensive X-ray treatment, would seem to be the best method of procedure.

### INTRATHORACIC GOITRE IN AN ELDERLY PATIENT

DR. WILLIAM B. PARSONS, JR., presented a man who was seventy-nine years of age when he came to the Presbyterian Hospital in the latter part of December, 1927, complaining of marked dyspnoea. The complaint had been in existence for two years, having started as the sequel to a severe coughing spell, after which he suddenly noticed a lump in the left side of his neck. Before that time breathing had been unobstructed, but following the partial dislocation of the left lobe of the thyroid, there had been gradually increasing dyspnoea, presumably caused by an angulation of the trachea at the superior thoracic aperture, not having been present when the thyroid was completely intrathoracic. When he presented himself, he had a mild upper-respiratory infection which had resulted in marked hoarseness and a great increase in dyspnoea.

Except for a prostatectomy in 1914, and some exploratory operation on the kidney in 1915, his general health had been excellent throughout his long life. As far as he knows, he was the only member of his family to have a goitre. There was certainly none present in his four sisters and six brothers, and none in his antecedents as far as he knows. With the exception of a large nodular goitre with marked tracheal displacement to the right, his general physical examination revealed an unusually active and well-preserved man of seventy-nine years.

Operation, under local anaesthesia, revealed a marked enlargement of the left lobe of the thyroid due to the presence of many adenomata with some large and small cysts. In one section, microscopically, there was a surprising preponderance of lymphoid tissue. The other lobe contained a few small, firm nodules, and was not disturbed. Ordinarily, of course, a bilateral procedure would have been followed, but because of his age, and the fact that he was somewhat tired after the left side had been attended to, the operation was limited to removal of the intrathoracic adenomata. The procedure followed was similar to that well described by Pemberton in the 1921 *Archives of Surgery*, namely, the control of the superior vessels, the division of the isthmus and the avoidance of dislocation of the intrathoracic portion until the inferior thyroid vessels had been controlled. Since operation, this patient has followed his occupation of upholsterer with marked improvement in his comfort.

### ILEOSTOMY IN EXTREME CASES OF TOXIC ILEUS

DR. WALTER A. SHERWOOD presented three cases.

CASE I.—A boy, eleven years of age, was admitted to the Brooklyn Hospital September 19, 1929, with the typical story of acute appendicitis and spreading peritonitis. He had been ill for three days with severe abdominal pain and repeated attacks of vomiting. When first seen he was extremely ill and showed every evidence of a well-advanced general peritonitis. The temperature was 102° F., pulse rate 120. The white blood cell count was 12,000 with 94 per cent. polymorphonuclears. The urine showed 2 plus acetone. The abdomen was markedly distended, there was board-like rigidity of all abdominal muscles and although tenderness was generalized it was most marked in the right iliac fossa. An immediate drainage operation seemed indicated and the abdomen was opened through a right rectus incision. Free purulent fluid escaped in large quantity. The extremely poor condition of the patient did not warrant a further search for and removal of the ruptured appendix. A rubber drainage tube was intro-

## ILEOSTOMY IN EXTREME CASES OF TOXIC ILEUS

duced into the pelvis and a second one was placed in the lateral gutter between the cæcum and abdominal wall. The peritoneum was closed in the usual manner; the muscles and fascia were only partially sutured and the superficial structures protected with side bolsters of rubber tubing. The post-operative course of the patient was a very stormy one. Distention was extreme, particularly of the upper abdomen; the patient vomited repeatedly and presented the typical appearance of one gravely ill with a peritonitic toxæmia. Lavage, intravenous glucose and hypodermoclyses were employed at regular intervals but with only temporary relief of symptoms. Seven days after operation the wound became disrupted and a loop of small intestine protruded through the lower angle. This was freed, dropped back in the abdominal cavity, and held in place by a layer of rubber-dam ten inches square. The wound was re-sutured and the structures approximated with through and through mass sutures of blue tension silk. The gastro-intestinal paresis continued and was partially kept in check by repeated stomach washings and enemata.

The patient lost flesh rapidly and became dehydrated. Two blood transfusions of 300 cubic centimetres each were given as supporting measures and seemed to be helpful. Three weeks after operation the distention was more difficult to control. Enemata were given without result and the patient exhibited the signs of a definite mechanical obstruction. Visible peristalsis was present in the upper abdomen and large quantities of dark-greenish material were being regurgitated. He was again taken to the operating room and through a left rectus incision slightly above the level of the umbilicus, the first presenting loop of distended small intestine was brought out, a trochar and cannula were introduced, allowing the escape of large quantities of fluid intestinal content and gas. A rubber catheter was introduced into the bowel through the trochar puncture wound and held in place after the method of Witzel. The intestine was dropped back and the wound partially closed. On the day following this simple procedure the entire clinical picture had changed. Vomiting ceased. Distention completely disappeared and the abdomen became soft and scaphoid. Normal bowel action was established on the second day, and from this time on improvement was continuous and rapid. The discharge from the opening in the small intestine was profuse for a week, at the end of which time the catheter was removed and the opening plugged with gauze. In another week the fistula ceased to discharge and the wound healed rapidly. The patient left the hospital early in November and has remained well. He presents a rather badly scarred abdominal wall with some weakness of the muscular structure which may require subsequent repair.

CASE II.—A boy, ten years of age, was admitted to the hospital November 11, 1929, with a three-day history of abdominal pain and vomiting. Examination revealed moderate distention, generalized tenderness and rigidity, most marked in the right lower quadrant. Temperature 101.2° F. Pulse rate 125. Respiration 30 and of the costal type. White blood cell count 19,000 polymorphonuclears 87 per cent.

An immediate operation was done, the abdomen being opened through a three-inch right rectus incision. There was free pus in the pelvis, and the appendix was buried in an omental mass at the pelvic brim. The tip of the organ was gangrenous and perforated. It was removed in the usual manner, the stump was buried and a rubber tube drain was introduced into the pelvis.

Following operation this patient was very ill with the characteristic signs of gastro-intestinal paresis of toxic origin. Vomiting and distention were only temporarily relieved by lavage and enemata. On the eighth post-operative day abdominal cramps, distention and repeated vomiting suggested the probability of mechanical obstruction. He was again taken to the operating room and through a two-inch left rectus incision an enormously distended small intestine was seen. Several organized omental bands were freed, and a small quantity of creamy pus escaped. A puncture wound was made in the distended bowel which was thought to be the midportion of the ileum and after large quantities of gas and intestinal content had been evacuated, a rubber catheter was intro-

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duced through the puncture wound and held in situ by the Witzel method. The intestine was dropped back and the wound left open except for a light gauze packing around the tube.

From this time on there was no further vomiting; distention disappeared rapidly and normal bowel action was established on the second post-operative day. The tube accidentally slipped out on the third day following which there was a temporary cessation of discharge and increased distention. This was later followed by a profuse discharge with rapid and complete recovery. Within ten days there was no further leakage of intestinal contents; the wound healed promptly and the patient left the hospital and has remained well.

A third case of an exactly similar nature was to have been presented this evening. She was a young girl, six years of age, with even a more severe grade of peritoneal toxæmia than those presented. The same procedure was carried out with recovery of the patient, but a complicating mastoiditis made it unwise to transport her from the hospital. In this instance the intestinal fistula is not yet healed.

### COMMENT

These three cases occurred within a few weeks of each other and although, in the past, while he had been rather indifferent in his advocacy of secondary ileostomy for the relief of toxic ileus, he was nevertheless firmly convinced that in each of these cases this simple procedure proved to be a life-saving measure in patients who would otherwise have succumbed to the profound toxæmia of general peritonitis. He was recently asked to see a patient at another hospital in consultation, who was also suffering from an extreme grade of toxic ileus associated with peritonitis following an hysterectomy. She was extremely ill, enormously distended, vomiting persistently and not relieved by any of the generally used measures. An ileostomy was advised, performed by the surgeon in charge of the patient and he has been informed that she is making a satisfactory recovery. This simple measure should be more generally utilized in similar conditions.

DR. SEWARD ERDMAN recalled that he had reported on similar cases from the New York Hospital which he had reported to this Society a few years ago. In the discussion Doctor Mathews expressed the opinion that many unnecessary operations were done; a statement to which probably all will agree. The reason Doctor Erdman referred to this now was because of the title, toxic ileus, given the two first cases. He was sorry the third case had not been presented more in detail as there were indications that this was a toxic case, but he did not consider that the two cases presented had toxic or paralytic ileus. Undoubtedly both originally had spreading peritonitis, but when the indications for enterostomy are not clear before the twenty-first day after the primary operation, as in the first case, and the eighth day in the second case, the speaker believed those cases came under the heading of mechanical ileus. Experience shows that the mortality and prognosis of enterostomy is different in the two types of cases; if enterostomy were done within three days after operation for peritonitis one might feel one was dealing with the ileus of peritonitis or toxic, paralytic ileus. But when one is able to wait for a week or ten days the patient is overcoming the toxic

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phenomenon and one is dealing rather, with mechanical ileus in which enterostomy sometimes works like magic and has saved lives.

DR. FRANK S. MATHEWS considered the first case reported by Doctor Sherwood as being a particularly appropriate one for ileostomy. The peritoneal sepsis had apparently been overcome and was followed by obstructive symptoms, probably due to loose recent adhesions. In such a case the patient's condition would not warrant an exploration to discover the point of obstruction and possibly this point would be hard to locate. The ileostomy was life-saving at the moment, and later the obstruction presumably relieved itself by the stretching out and disappearance of the adhesions, which in such cases probably is dependent upon peristalsis of the intestines.

DOCTOR SHERWOOD, in closing the discussion, said that he regarded Doctor Erdman's criticism as a fair one. He expressed his regret at not being able to present the third case which was more representative of true toxic ileus. In this case ileostomy had to be done at the end of the sixth day following the original operation. Although it may be assumed that mechanical obstruction had supervened in each of these patients, the underlying cause of the trouble was a paralytic ileus, as the result of which the small bowel became overdistended with fluid, dropped into the pelvis of its own weight and became obstructed as the result of torsion or angulation.

## CYSTIC TUMOR OF THE SCAPULA

DR. WALTER A. SHERWOOD presented a girl, eight years of age, who was admitted to the Brooklyn Hospital in August, 1929. Three weeks previously her mother had noticed a mass protruding from the region of the right shoulder blade. Her only complaint was slight pain on motion of the arm. Over the right scapula and apparently connected with the body of the bone was a firm hard mass about the size of an orange. There were no inflammatory signs and the overlying skin was freely movable. The range of motion in the shoulder joint was but slightly impaired.

Stereoscopic X-ray study revealed a bony tumor involving most of the body of the scapula and having the general appearance of an osteogenetic sarcoma.

August 16 the scapula was resected through a transverse incision. The tumor involved the entire body of the bone. Grossly the mass appeared to be a degenerating sarcoma. The neck was divided with chisel and bone-cutting forceps and the body, including tumor, muscles and scapular spine were removed. The subscapularis muscle was left intact. The muscle stumps and skin flaps were sutured and a cigarette drain was introduced. The wound healing was prompt and satisfactory.

*Pathology*—Microscopic examination showed a benign cystic bone tumor of the giant-cell type. It is now five months since this tumor was removed. Recent X-ray studies failed to reveal any evidence of intrathoracic or other remote metastases. The local condition is excellent. It would seem that the pathologist's report that this is a benign giant-celled tumor is in all probability correct. The case is presented because of the comparative rarity of such growths in other than the long bones and because of the excellent functional result obtained coincident with the extensive sacrifice of large and important structures on the dorsal surface of the scapula, principally the supra- and infra-spinatus muscles and the major portion of the scapula itself.

## SPLENECTOMY FOR CHRONIC PURPURA HÆMORRHAGICA

DR. WALTER A. SHERWOOD presented a woman, thirty-nine years of age, who was first admitted to the medical service of the Brooklyn Hospital September 15, 1928,

because of persistent bleeding from the nose and bowel. She had purpuric spots on various parts of her body which she had first noticed on the day before admission. She stated that she had been in good health except for a skin lesion (lupus erythematosis) for which she had been under treatment with hypodermic injections of a colloidal gold preparation and to this treatment she attributed her bleeding. She had never noticed any tendency to excessive bleeding nor was there any suggestive family history of a similar condition. She was a well-nourished, drowsy, anæmic woman, who seemed acutely ill. The skin over the entire body was studded with subcutaneous hæmorrhages, ranging from large ecchymotic areas to small petechiæ. These were noted on the conjunctivæ on the roof of the mouth, over the flanks, trunk and extremities. The positive findings at this time were mostly limited to the skin and mucous membranes. Heart and lungs negative. There was no lymph-adenopathy, the liver and spleen were not palpable and no masses were felt in the abdomen. On admission the body temperature was 99.4° F. Pulse rate 86, quality weak. Blood examination revealed: Hæmoglobin, 35 per cent.; red blood cells, 2,000,000; color index, 0.9; white blood cells, 8,800; polys, 78 per cent.; lymphocytes, 22 per cent.; platelet count, 128,000; coagulation time, 5 minutes; bleeding time, prolonged; blood Wassermann, negative.

On the second day following admission the patient became markedly worse. She vomited blood repeatedly and passed large amounts of fluid blood and clots from the bowel and vagina. The urine was also found to contain gross blood. During the first week of her stay in the hospital she was given four blood transfusions. After the last transfusion she began to improve and the amount of bleeding decreased. Moderate oozing continued for three days and a fifth transfusion was given. The hæmoglobin then increased to 60 per cent. and the skin ecchymoses gradually disappeared. The patient felt much better and was discharged greatly improved on October 16, 1928, to return to the out-patient department for continued observation. Three weeks previous to her second admission to the hospital on January 7, 1929, she noticed that the purpuric spots were reappearing and became so numerous that she became alarmed. On admission there was the same distribution of petechiæ as before although as yet no gross bleeding. The hæmoglobin at this time was 78 per cent., erythrocytes 4,000,000 and the platelet count was 112,000.

On the fifth day after entering the hospital vaginal bleeding again started and continued up to the time of operation. Repeated examination of the blood showed a rapidly advancing anæmia and she was given three supporting blood transfusions. A clot retraction test revealed that there was no retraction at the end of forty-eight hours. She also had a positive tourniquet test. The platelet count was now 44,000.

The patient steadily became weaker and on February 18, the advisability of splenectomy was considered. At this time the relationship of the gold injections to the present condition was discussed and the relationship considered only coincidental.

February 21, after a preliminary blood transfusion, a rapid splenectomy was done through a left rectus incision. There was moderate perisplenitis as evidenced by numerous adhesions. No particular difficulty was experienced, and a spleen which appeared normal in size, consistence and color was readily removed. At operation there was a moderate amount of general oozing, but this was readily controlled with hot pressure pads and the usual measures. The wound was closed without drainage.

The recovery from operation was uneventful except for an elevation of temperature which continued for twelve days and could not be accounted for. The pathological report stated that the spleen was of normal weight and appearance and the microscopical findings were those of a normal spleen. Three days after operation the platelet count had risen to 190,000. On the ninth day the hæmoglobin was 80 per cent. and the red cell count 4,480,000. From this time on recovery was rapid and there were no further evidences of bleeding. The patient left the hospital in excellent condition and has remained well. The case is reported for the purpose of recording an additional one of persistent and uncontrollable purpura hæmorrhagica in which removal of the spleen

## SPLENECTOMY FOR BANTI'S SYNDROME

seemed to have an immediate and decidedly beneficial effect in altering both the blood picture and its coagulability. The rapid increase in the platelet count following operation was of especial interest.

DR. EDWIN BEER suggested that the post-operative rise in temperature, which continued for twelve days in this case, which always occasions some perplexity, was due to injury to the tail of the pancreas. He had seen such febrile movements repeatedly in undrained splenectomies and had been in doubt usually as to the cause.

DR. JOHN F. CONNORS stated that he had frequently noted this rise in temperature in the cases of splenectomy which he had done for trauma. In these cases, which were done hurriedly, it was thought that it was due to injury done to the tail of the pancreas by catching it in the ligature of the splenic vessels. Subsequently, in some, although not all of these, there was a breaking down of the abdominal wall which led to this conclusion.

## SPLENECTOMY FOR BANTI'S SYNDROME

DR. WALTER A. SHERWOOD presented a young man, seventeen years of age, who entered the hospital October 18, 1929. His chief complaints were pain in the upper right side of the abdomen and vomiting of blood. Six months previously, while at work, he suddenly vomited a large quantity of blood. This was followed by tarry stools; subsequent to this he was weak and anæmic and remained in bed for seven weeks. He apparently recovered from this attack, although his pallor continued.

Ten days previous to admission, he again had a feeling of faintness, went to bed, and on the following morning vomited over a quart of bloody material, with many clots. The stools were very dark and continued to be so up to the time of entering the hospital. On the day following admission he again vomited blood, complained of air hunger, and was very restless.

Family and past personal history was negative. Examination revealed a very anæmic, weak patient, with marked greenish yellow pallor of the skin. He had a systolic heart murmur at the apex. The spleen was palpably enlarged, tender, and firm. There was tenderness in the right iliac fossa, with the suggestion of a mass in this location. Admission temperature was 103.6° F. Pulse rate 110. Blood-pressure 130/50.

Blood examination: Hæmoglobin, 22 per cent.; red blood cells, 2,560,000; blood platelets, 32,000; white blood cells, 8,000; polymorphonuclears, 85 per cent. Blood culture, smears and Widal negative. Coagulation and bleeding time each three minutes. Clot retraction time normal.

The urine was negative except for the presence of few red and white blood cells.

Stools positive for blood. Icterus index 3.9. Vandenberg test showed no reaction. Fragility of cells normal. Smears for malarial parasites negative.

A provisional diagnosis of bleeding gastric ulcer was made, but could not be substantiated by subsequent study. Treatment consisted of an appropriate diet and blood transfusions. He did well for a time. The hæmoglobin increased to 45 per cent., after which he had another severe gastric hæmorrhage, and the hæmoglobin again fell to 28 per cent. Following repeated transfusions the blood picture improved, and a probable diagnosis of Banti's disease was made on the basis of splenomegaly, the presence of a small amount of free ascetic fluid in the abdomen, and the repeated gastric hæmorrhages. Splenectomy was advised and performed on December 9, 1929.

There was marked perisplenitis, and considerable difficulty was experienced from massive hæmorrhage following the manual release of adhesions. The bleeding was controlled with a gauze tampon and pressure, after which the enlarged spleen was

easily delivered and removed. There was a moderate amount of clear free fluid present, and the liver, though small, did not show any of the characteristic cirrhotic changes. Exploration of the stomach and duodenum failed to reveal any evidence of an ulcer or other lesion which might have been responsible for the previous hæmorrhage. A post-operative blood transfusion was given, with much benefit. The patient has made a satisfactory recovery, with steady improvement in his general condition and appearance. In the past two weeks he has gained ten pounds.

The most recent blood examination is as follows: Hæmoglobin, 53 per cent.; red blood cells, 3,200,000; platelets, 125,000.

*Pathology.*—The spleen is 20 centimetres in length, 10 centimetres wide, and 8 centimetres thick. Weight 550 grams. The capsule is thickened, purplish gray, with numerous white thick patches. The vessels on the hylic side are enlarged and prominent. On section the follicles are readily visible, and the connective tissue framework is increased in amount. *Histological.*—There is a definite increase in fibrous tissue, markedly augmenting the total bulk of the organ. The pulp is decreased and the venous spaces are enlarged and have thickened walls. *Diagnosis.*—Interstitial fibrosis of the spleen. The findings are consonant with the clinical entity known as Banti's disease.

*Comment.*—Because of the difficulty experienced in controlling dangerous hæmorrhage in this case, the suggestion is ventured that no operation on the spleen should be attempted without a preliminary transverse incision in addition to the vertical one. The failure to utilize this additional exposure on the patient, except as an afterthought, greatly increased the technical difficulties of the operation and added to its risk.

DR. RICHARD LEWISOHN, speaking of the incision for splenectomy, stated that he always made an incision along the left costal arch which allowed a perfect exposure. He considered that this incision was preferable to a longitudinal incision through the left rectus.

#### ANALYSIS FOR ONE HUNDRED AND FORTY-EIGHT OPERATIONS FOR GOITRE

DR. CHARLES GORDON HEYD read a paper with the above title for which see page 496.

DR. EDWARD R. CUNNIFFE asked Doctor Heyd how he prepared these goitre patients for operation. The speaker had had some experience with similar cases which he regarded as the most troublesome of all surgical subjects. Two cases had recently come under his care who had been on iodine medication for a period of eighteen and ten months respectively. He withheld iodine for four months and then administered Lugol solution for ten days, at the end of which time he resected one lobe. Eight weeks later he resected the other lobe. Both of his patients recovered, but he was not at all sure that his had been the best way to treat them and asked Doctor Heyd's opinion. Doctor Cuniffe regarded, as the most serious danger in these operations, the possibility of injury to one or both of the recurrent laryngeal nerves. In all large clinics such injuries have occurred; consequently they are not to be passed over lightly. He thought it required considerable courage to use rectal anæsthesia, ethylene gas, or any form of general anæsthesia which prevented the patient from speaking during the operation. If one could recognize the nerve injury immediately through a change in the breathing, it would be safe enough, but the speaker felt that the only sure way in

which a nerve injury can be immediately recognized is by a change in the voice sound. Therefore, he has for the past three years used local anæsthesia. This form of anæsthesia has given him no trouble even in the most toxic forms of goitre, or in those cases with the most marked nervous symptoms. When using a local anæsthetic, one is able to carry on a conversation with the patient during the entire operative procedure. If the nerve has been injured by a clamp or ligature an immediate change in the voice will give warning and the nerve may possibly be freed of this clamp or ligature, in which case a complete restoration of the function of the nerve will occur in about six weeks. Of course, if the nerve is severed the loss is complete and permanent, but the patient is still protected for one would not then proceed with the remaining lobe lest one might injure the other nerve. Doctor Cuniffe considered local infiltration anæsthesia as an ideal anæsthetic in these cases.

DR. ARTHUR S. McQUILLAN said one point in Doctor Heyd's classification of goitre had seemed confusing. Why did he subdivide goitre of adolescence as "physiological gland with overfunction"? To the speaker the goitre of adolescence represents a great group, most of which are those of hypothyroidism, a compensatory hypertrophy resulting from too many demands made on a poor quality of thyroid tissue. In his operative cases, classed as hyperthyroidism of adolescence, why distinguish them from the group of Graves' or hyperplastic goitre? In regard to the use of the term thyroxin secretion instead of thyroid secretion: the latter means something more than thyroxin. Kendall claims that thyroxin represents only a fraction of the thyroid hormone. The question of iodine therapy is always unsettled. Many workers report different results, but most report that iodine given for a certain period has its best effect when the patient with Graves' disease has never had it before. But it is rare to find such cases, as most of these patients coming for surgical relief have been taking iodine for months and sometimes for years. They are overdosed and in that type it is generally agreed that iodine has not much beneficial effect. Then too there are cases refractory to iodine from the first. It is a question what to do in such cases in addition to prescribing rest in bed and forced feeding. Then comes the question of ligation and whether that is worth while. Of course everything should be done to bring down the metabolism and so decrease the risk of operation to the minimum. In those severe cases that iodine will not relieve, ligation is indicated and will often bring about the possibility of a safe resection. Another point about which Doctor McQuillan was in doubt was Doctor Heyd's statement that there is an increase of iodine in the blood in cases of severe toxic goitre. Investigation of the presence of iodine in the blood is a very difficult test, for it is there in such small quantities that a large amount of blood must be secured. The results of such a test are not apt to be reliable. In regard to the distinction between Graves' disease and toxic adenoma, Doctor McQuillan agreed with Doctor Heyd that in many respects they are very different clinically. While the majority of cases of



Graves' disease are acute, some come on mildly and slowly. Most of the adenoma cases will give a history of a nodule for months or years with only recent toxic symptoms. In regard to the convalescence in goitre cases, especially Graves' disease, many do well, or it seems so because very soon after operation the heart rate becomes slower and the patient has an almost normal basal metabolic rate. The question is how well can he stand his work and the ordinary stress and strain of life? It has been Doctor McQuillan's experience that it takes about two years for the patient to become strong enough to work without fatigue. Very often his ordinary work tires him and he has a rapid heart or some other similar symptoms. Iodine is beneficial during this period. In many cases there will be signs of hypothyroidism and a low basal metabolism, and still the pulse will be rapid. In that group many benefit by thyroid feeding instead of iodine. In regard to anæsthesia, the speaker agreed that the use of ethylene is best. Doctor Heyd had reported a series of cases in which sodium amytal had been used. The speaker had had only one experience with it. His patient was ideal for the use of amytal and the effect was all that could be desired until four hours post-operative when she took a serious turn with a sudden partial respiratory paralysis requiring artificial respiration. Eventually she recovered, but had a very stormy time for two or three days. In regard to post-operative tracheitis, Doctor McQuillan had noticed that skinning off the trachea very closely produced distressing symptoms. He rather doubted the wisdom of leaving thyroid tissue on the trachea as it is apt to grow and cause a nodule to form. If in dissecting, one can keep between the pre-tracheal cervical fascia and the true capsule of the thyroid gland, post-operative tracheitis is much less likely to occur. In regard to nerve injuries, the speaker believed they are rather rare in comparison with the number of thyroidectomies that are done. One is most apt to injure the nerve in a case in which the nerve has been displaced. This happens in adenoma cases where a small amount of thyroid tissue exists between the trachea and the nerve, throwing the nerve out of position. Many cases of nerve injury occur by attempting hæmostasis blindly, either including too much thyroid tissue in a clamp or by working in a pool of blood. There is no reason for the latter as hæmostasis can be always temporarily controlled by pressure. Doctor Heyd deserved congratulation on this series of cases which represented very careful work not only on his part, but also on the part of his assistants. If there is any branch of surgery which is not a one-man job, this of the thyroid is the one, for so much depends on the anæsthetist and the assistants. Team work makes for the safety of the thyroid patient, but in spite of refined methods of surgical technic, and the controlling action of iodine, thyroid surgery is not at the present time divorced from many hazards.

DR. WILLIAM BARCLAY PARSONS, JR., said that in his experience iodine was useful as a pre-operative preparation in both exophthalmic and toxic adenoma cases. As a rule, the improvement in the exophthalmics was more marked, probably due to the fact that the degree of hyperthyroidism in

these cases is greater than in those due to so-called toxic adenoma; but qualitatively as the hyperthyroidism is identical in both groups, the reaction, though differing in amount, will be identical in nature. There was a wide difference in opinion as to whether iodine causes hyperthyroidism in a simple adenoma. The speaker had never as yet been able to persuade himself that iodine has ever made an active or inactive thyroid worse. Cases where this was apparently so were due to coincidence or to persistence of symptoms after the wearing off of a temporary effect by the iodine, and were not caused by the iodine itself. He considered it inconsistent and illogical to regard the same drug as able one day to make a patient worse and a few days later to make him better. He felt that it should not be used at all in cases of simple adenoma, as it does them no good, and this practice is apt to lead to the indiscriminate use of iodine, which is particularly bad in cases of hyperthyroidism at other times than the pre-operative period.

DOCTOR HEYD rejoined, in reply to Doctor Cuncliffe's criticism, that there were a fair number of patients who had hyperthyroidism for many years. These patients were elderly, had chronic cardio-vascular disease, chronic Bright's disease, and the majority of them had been taking iodine in rather large dosage. These patients could not be prepared before operation in any noteworthy degree. The series just presented was an analysis of 148 operations for goitre and was not intended to be a dissertation on Graves' disease. It was always felt that it was wise to take every case coming in that needed surgery and do the best that was possible for it. It is interesting to note that during the time this series was run there were more deaths from hyperthyroidism, while waiting for surgery, than there were from operative intervention. Furthermore, none of the cases in the series had been operated on under local anæsthesia for the simple reason that in a properly conceived technic the recurrent laryngeal nerves should be neither exposed nor subjected to direct trauma. It was a firmly established belief that when one was in juxtaposition to the nerves and there was the possibility of their injury that the patient would give unmistakable evidence in change in breathing sounds. Doctor Heyd had seen a number of thyroidectomies under local anæsthesia, particularly abroad, and his reasoned conclusion was that it was inimical to a patient with severe hyperthyroidism to have a prolonged operation under local anæsthesia, at the conclusion of which the patient could phonate as well as before the operation, but was in a state of physical and mental collapse. Again, most of the nerve disabilities occurred some time after the operation and were due to factors that could not be prevented by the administration of a local anæsthetic. In regard to the criticism of Doctor McQuillan, adolescent hyperthyroidism was listed purely for a clinical convenience. A great many young children with basal metabolism of plus 12 to plus 14 showed the clinical evidence of a beginning hyperthyroidism. The majority of these patients had the stigmata of an incomplete physical development and, in

addition, showed faulty habits of living and poor physical hygiene. By the removal of tonsils, clearing up of infections and rest, most of these patients recovered and were listed as simply a functional hypersecretion. A few, however, passed on into well-defined cases of Graves' disease and these were termed adolescent hyperthyroidism. In Graves' disease, it was felt that the introduction of iodine as a pre-operative measure for a week or ten days before operation accomplished as much as had ever been done by ligation. One could enter into an endless discussion as to the merits and demerits of iodine, but this was not the time for it. Doctor McQuillan had questioned the statement, "There is an increase of iodine in the blood in cases of Graves' disease." This is based upon the work of Reid Hunt. A discussion of the subject will be found in the *Journal of the American Medical Association*, 1907, vol. xlix, pp. 1323-1329. Further authority is found in a paper by Charles H. May, in *Surgery, Gynecology and Obstetrics* for April, 1912, p. 365, where the following statement appears: "Less iodine is found in colloid goitre than in the normal when both are compared bulk for bulk. In exophthalmic goitre the iodine is decreased below that of the normal, and Reid Hunt has shown that in hyperthyroidism it is present in excess in the blood." As to the results of operation, it was Doctor Heyd's opinion that the chronic hyperthyroidism of Graves, disease type was never 100 per cent. cured, no matter what was done for it. While the patient subsequently enjoyed relatively good health and the basal metabolic readings would be normal, there was always a tendency to tachycardia and emotional disturbance. In regard to anæsthesia, ethylene was believed to be the anæsthetic of choice *par excellence*. Rectal anæsthesia was also very useful, the only objections to its employment being that it requires considerable detailed preparation; it is a time-consuming procedure, and the operator has to wait upon the details of the anæsthesia. To have an eight thirty A.M. operation under rectal anæsthesia means that the nurses and anæsthetist must begin preparing the patient above five A.M. Most hospital authorities object to this early starting. Doctor Heyd could not quite understand Doctor Parson's philosophy of iodine in goitre. His own experience suggests that iodine is the greatest aid he knew of as a preliminary to operation in Graves' disease. The unfortunate thing about the giving of iodine in goitre has been its wholesale administration by the profession and self-medication by the laity. It is an outstanding exception to have a patient come to the Goiter Clinic with a goitre who has not had iodine. Doctor Smith raised the question that according to the tables submitted in to-night's essay, the pre-operative treatment averaged only four days. This is true in the cases analyzed, but it does not hold true in the Graves' disease cases where the average pre-operative period was approximately seven days. The four-day period was obtained, of course, by the dilution represented in the colloid goitres. When the operator stated that he removed two-thirds or four-fifths of either the right or left lobes of the thyroid gland he was using relative terms. It was the operator's reaction to the size of the thyroid

lobe and his own opinion as to how much to remove. The removal of adequate amounts of thyroid and, at the same time, not too much was a fine decision and one in which any conscientious operator could err on the side of safety. As to his experience with amytal while it has not been extensive it has been used in a fair number of cases. In only one case, however, was any dosage used sufficient to obtain complete general anæsthesia. This was in a patient with carcinoma of the thyroid, whose calculated anæsthetic dose was 1.4 grams. When the patient had received 200 milligrams intravenously she went to sleep and received in all 1.2 grams of amytal. She was totally unconscious and fully analgesic and a complete bilateral thyroidectomy with removal of the isthmus was carried out without the addition of any other anæsthetic agent. The other cases received from 0.8 to 1.0 grams, sufficient to produce complete unconsciousness; the patients were then removed from the ward, or private room, to the operating room and ethylene anæsthesia administered. The intravenous injection of amytal appeared safe and accomplished all that was previously obtained with rectal anæsthesia, namely, complete unconsciousness, and no memory upon the part of the patient of any of the procedures from the time the amytal was started intravenously, until three or four hours after the completion of the operation.

# BRIEF COMMUNICATIONS

## CARCINO-SARCOMA OF THE THYROID

AMONG the mixed tumors of the thyroid are those of special interest which present both kinds of malignant growth, carcinoma and sarcoma.

There are two possibilities: Either the two tumors are developed in different parts of the organ or they are more or less closely mixed. An example of the former type is given in the case of Saltikow, who found carcinoma in one lobe of the thyroid and sarcoma in the other. Both tissues met in the isthmus.

These cases are extremely uncommon. Generally carcinoma and sarcoma are interwoven, sometimes very closely. Schupiser calls this type of carcino-sarcoma "Collisions tumor" and distinguishes it from the "Compositions tumor" in which the two kinds of malignant tissue are more or less mixed.

The question arises: Are sarcoma and carcinoma etiologically independent from each other, or does the existence of one of them provoke the development of the other?

Simmonds believes that both kinds of blastoma are due to the same unknown cause and that regarding their etiology they are independent from each other.

The majority of the pathologists think, however, that either the presence of the sarcoma causes a malignant change of thyroid epithelium into carcinoma or that the presence of the carcinoma leads to a change of the stroma into sarcoma. In spite of the fact that in the greater number of cases the sarcoma is predominant in mass, only Saltikow maintains the idea that sarcoma is the primary growth, which later causes the development of carcinoma. All the rest of the authors, *e.g.* Schupiser, Albrecht, and Herxheimer, cling to the opinion that originally carcinoma develops and later sarcoma. Several case reports and especially experimental cancer research seem to confirm this conception.

Of the case reports, we have one by Schmorl, in which a suspicious adenoma of the thyroid was removed. Recurrence took place in the way of a carcino-sarcoma. On death of the patient, sarcoma only was found in the second recurrence with metastases in the fascia, lungs, liver and kidneys.

Wells reports a case of carcino-sarcoma in the thyroid of a dog. In the metastases he found pure carcinoma in the cervical glands while the kidney, heart, and intestines showed pure sarcoma. In the lungs, however, most of the nodules were found carcinomatous; but some contained both types of growth, just as it occurred in the primary tumor.

Georg Schöne found a carcino-sarcoma in the thyroid of a dog, and metastases of a spindle-cell sarcoma in the lungs.

Nassetti describes a case of carcinoma of the thyroid which returned as a pure spindle-cell sarcoma.

Of the greatest importance are the observations of Ehrlich and Appolant in experimental mouse cancer. These workers transplanted mouse carcinoma from generation to generation. In the thirteenth generation they found a spindle-cell sarcoma, to their great surprise. Upon reëxamination of former specimens, they were able to demonstrate carcino-sarcoma in the tenth, eleventh, and twelfth generation. In the thirteenth generation only a few carcinomatous islands were left. In the fourteenth generation the cancer had disappeared entirely, and the tumor continued to be a sarcoma in over fifty generations.

In another experiment the carcinoma also changed into carcino-sarcoma, but the carcinomatous tissue never disappeared and the tumor continued to

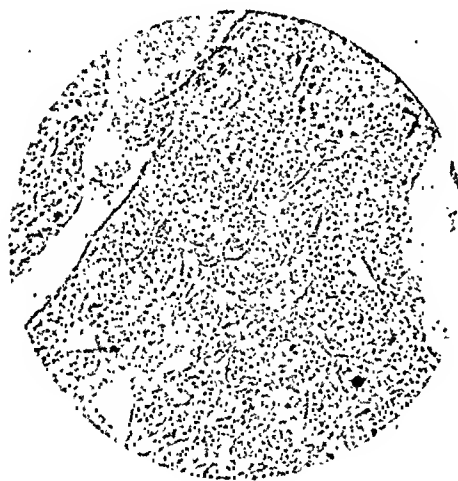


FIG. 1.—Carcinoma.

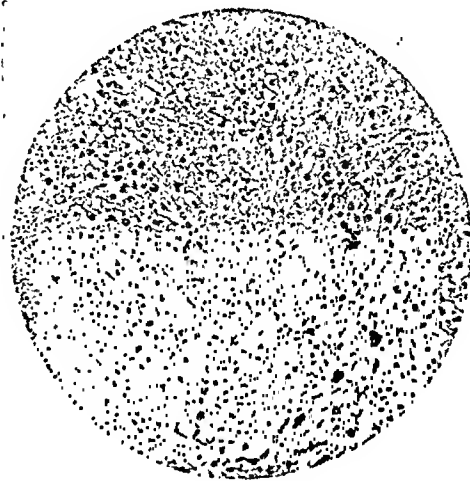


FIG. 2.—Sarcoma.

be a carcino-sarcoma through all generations during nine months of observation.

A third set of carcinomatous mice showed at first intense degeneration of the carcinoma; then from the fortieth generation intense development of the stroma. Suddenly in the sixty-eighth generation, after two and one-half years had elapsed, a typical carcino-sarcoma occurred.

Occasionally a few cancer alveoli were found in the next generations but soon the cancer cells disappeared entirely and pure sarcoma continued.

Appolant lays special stress upon the fact that the sarcomatous tissue is always in the periphery. He is not in accord with Kronpechner's belief that the change from epithelial tissue into sarcomatous tissue is possible.

CASE REPORT.—White male, aged seventy, noticed a slight swelling of his thyroid gland about six months previous to entering the hospital. For three months he had some difficulty in swallowing and breathing. He did not notice other symptoms of any importance, but he felt a certain increase in nervousness. He had lost about twenty pounds in weight in the past two years, and perhaps half of this in the last six months. The thyroid gland was firmly fixed and extended from the point of the chin to five centimetres below the clavicle and laterally from the sternocleidomastoid almost to the level of the lower border of the ear.

## BRIEF COMMUNICATIONS

A tumor the size of a cocoanut, weight 470 grams, was removed by Dr. O. R. Lillie. After an uneventful recovery, the patient left the hospital eleven days after the operation. He went to Michigan where he died of a recurrence three months later. No post-mortem examination has been made.

*Gross Description.*—The tumor was surrounded by a capsule and easily shelled out. It was of very solid consistency and in one area about the size of a dollar the tissue was softened and of yellowish color. The rest was of grayish-white color and did not look like thyroid gland. The tumor was composed of different nodules which could not well be separated from each other because of interlacing fibres.

*Microscopically* there were remnants of the proper thyroid tissue in a few sections, with alveoli lined by a cuboidal epithelium and containing a normal amount of colloid. Fig. 1 shows strands of epithelial cells. They are irregular in size and shape and the nuclei hyperchromatic. Although the structure of the cells resembles the epithelium of the thyroid gland, there is no formation of distinct alveoli and no colloid. In other slides (Fig. 2) there is a remarkable change of these epithelial cells. They are much

larger, both the nuclei and cytoplasm being increased. The nuclei are dark, hyperchromatic and show more mitoses than in Fig. 1. The cytoplasm is extremely clear, vesicular and sometimes the nucleus is pushed to one side and becomes sickle-shaped. The grouping in strands has disappeared and the cells form one solid mass.

Bassal and Rigaud have described in their paper a case which presents exactly the same structure of the cells as my case.

In Fig. 3, we see at "A" the same solid strands as in Fig. 1, and at "B" the same vacuolized cells as in Fig. 2. Between these two groups we find irregular spindle-shaped cells which show many mitotic figures. They are poly-

morphous. In other sections they are grouped in irregular whirls, spindle-shaped and round-shaped cells alternating.

Examining a large number of sections, I found in the majority of them sarcoma only, and no carcinoma. The sarcomatous tissue was in many areas entirely necrotic.

An absolute proof of the malignancy of the blastoma was given by the invasion of many blood-vessels by strands of cancer cells.

*Summary.*—A case of carcino-sarcoma of the thyroid has been observed. The two tissues were intimately interwoven, the sarcoma being by far predominant and showing extensive necrosis.

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## XANTHOSARCOMA

VERY thorough studies about xanthoma have been given in the work of B. van den Hartog, Francis Harbitz, Eugen Kirch, and Paul Spiess.

Infiltrations of tissue by cholesterol have frequently been called xanthomata, regardless of whether they were neoplastic growths or not. We classify them into three large groups: (1) pseudo xanthoma; (2) Multiple symptomatic xanthoma (by Aschoff, called xanthelasma); (3) single xanthoma.

(1) Pseudo xanthoma, as the name implies, is not a true xanthoma; however we find in it certain cell groups containing cholesterol esters formed by reabsorption of soft fatty substances. Examples of pseudo xanthoma are found in brain abscess, in the walls of dermoid cysts and gall-bladders, and in pyosalpinx.

(2) Symptomatic xanthoma is found in diabetes and icterus; sometimes it has to be considered as a hereditary condition. In these cases, hypercholesteræmia is always present and is very characteristic for these growths. Furthermore we find, as a rule, multiplicity and instability of the growth, as well as degenerative processes. A typical example is the xanthelasma of the eyelid.

(3) Another large group of xanthomatous growths may be separated from the two former ones by the fact that only one place in the body shows infiltration with cholesterol. Therefore we call them single xanthomas. The great majority of these growths are true blastomas. Only occasionally xanthomatous infiltration takes place in a granuloma (Seyler).

Xanthomatous tissue has been found in fibromata, angiomata, and especially in sarcomata.

Cases have also been described in which xanthomatous changes occurred in tissue of epithelial origin. Dub found xanthomatous cells in carcinoma of the fundus uteri, and Kinoshita described xanthomatous carcinoma of the prostate. It is remarkable that xanthocarcinomas always develop in tissues which already contain cholesterol under physiologic conditions.

A relatively common xanthomatous blastoma is the sarcoma. We can distinguish two groups, xanthosarcoma of the extremities and xanthosarcoma of other localization. The latter are very rare. Examples have been described in the suprarenal gland, the tongue, parotid, labium, ileum and in the thoracic cavity.

It is of practical value to separate these xanthosarcomata from those of the extremities because the former are always malignant, while the latter never form metastases and only in extremely rare cases (as in the case of Beneke) show invasive growth.

Spiess distinguishes two histological types of xanthosarcoma of the extremities. In one there are many blood vessels surrounded by polyhedral cells as an outstanding feature. In the other type giant cells apparently of the osteoclast type predominate. We call the former type angiomatous, the latter giant-cell type.



## BRIEF COMMUNICATIONS

It was a strange coincidence that I found two cases of xanthosarcoma in one week, one of them representing the angiomatous type and the other the giant-cell type. Both tumors were also interesting on account of their localization. It is well known that the most frequent localizations of xanthosarcoma in the extremities are the fingers, the hand, the toes, less frequently the foot and the forearm. The most uncommon localization is in the leg. The two xanthosarcomata which will be described in the following case reports were both localized in the leg, one of them in the thigh, close to the fascia, and the other in the deep fascia of the popliteal space.

CASE I.—H. L., white, male, age fifty years, gave a history of having a tumor of the thigh for some years. It lay free, medial and posterior to the femur between the lateral and posterior groups of muscles. The growth was shelled out and removed by Dr. C. H. Evans without difficulty. Grossly it showed a marked nodular



FIG. 1.—Xanthosarcoma.

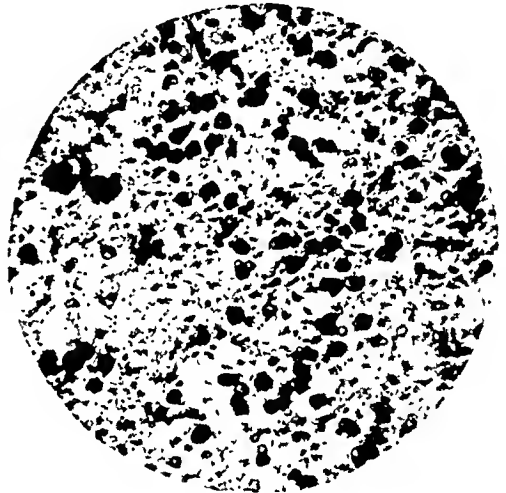


FIG. 2.—Xanthosarcoma.

structure. One of the largest of these, the size of a hen's egg, was of soft consistency and gelatinous. Another, the size of a plum, was more firm and showed many hæmorrhages. The remainder of the growth consisted of many small nodules of firm consistency.

Microscopically all the nodules showed the same structure, the only difference was a varying amount of œdema of the stroma. Studying the slides with low power (Fig. 1), there are many blood vessels surrounded by polyhedral cells varying in size and shape and imbedded in a dense network of fibrous tissue. Observation with high power makes the irregular character of the cells appear more striking and besides this the so-called foam cells with eccentric nucleus and large vacuoles are noticed. Frequently the nucleus is pushed to the side to such a degree that the cells present the form of a signet ring. When a fat stain is used, for instance Sudan iii (Fig. 2), we are able to prove that the contents of all these vacuoles consist of a fat-like substance. In some cells there are small droplets separated from each other, in others they fuse into one large drop.

In this case it was not possible to find any hæmosiderin with the Prussian blue reaction.

CASE II.—J. B., white, female, age twenty-nine years. A tumor had been present in the left popliteal space for seven years. It never caused any pain and grew

gradually. The tumor was the size of a large lemon and extended down to the deep fascial layer and was removed with some difficulty by Dr. T. S. O'Malley.

Grossly the tumor showed an irregular outline and presented a nodular structure. The average size of the nodules was that of an olive. They had a consistency of cartilage and cut readily with a knife. The cut surface showed bluish-white areas and a meshwork of yellow streaks.

Microscopically (Fig. 3) we find polyhedral and spindle-shaped cells imbedded in hyaline stroma. In addition there are giant cells containing more than twenty nuclei apparently of the osteoclast type. Furthermore we see many foam cells of the same type as in Case I. There are different stages of foam-cell production: in the beginning small droplets appear in the cell, later on the cell being decomposed, large drops are lying in the stroma.

Examination with the Prussian blue reaction showed a large amount of pigment.

Cholesterol determinations were impossible because of the inability to obtain blood specimens from these patients after operation.

## SUMMARY

(1) Two cases of xanthosarcoma have been reported: One of the angiomatous type showing many blood vessels, and one of the giant-cell type.

(2) Both tumors took their origin from the lower extremity; one from the fascia of the thigh, and the other from the fascial layers of the popliteal space.

(3) In both cases distinct foam cells were present. The fat could be stained with Sudan iii and osmium. In only one case hæmosiderin could be demonstrated by the Prussian blue reaction.

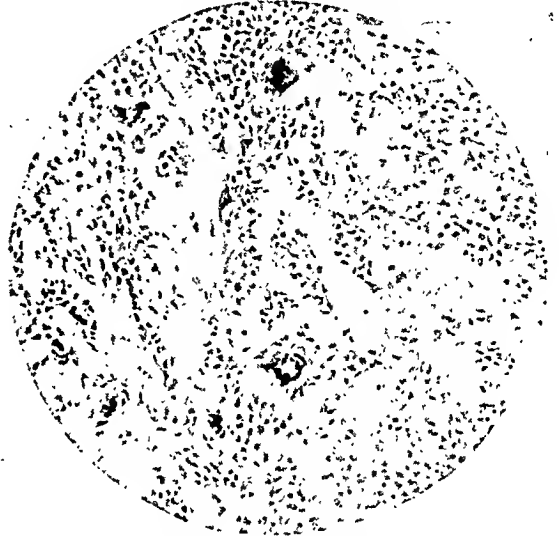


FIG. 3.—Xanthosarcoma.

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## NON-ROTATION OF THE COLON

THE following case is reported because of the rarity of the anomaly; and second, because of the unusual symptoms manifested.

CASE REPORT.—White, male, age twenty-seven years, was first seen by me July 17, 1928. His complaint was pain in the left side of his abdomen, associated with attacks

## BRIEF COMMUNICATIONS

of diarrhœa. He stated that he had never been well; that from infancy he had had some form of stomach trouble; and that as long as he could remember he had had frequent attacks of cramping pains in the left side of his abdomen, associated with diarrhœa. He described the pain as cramping in character, and radiating from the umbilicus downward toward the left. The pain had always been worse immediately following his meals, and in the early morning hours. The attacks of diarrhœa came on from thirty to forty minutes after his meals and persisted until he had had from two to four bowel movements. Following these short attacks of diarrhœa he was fairly comfortable until follow-

ing his next meal, when he experienced the same type of pain, associated with diarrhœa. He had been treated from time to time by various physicians without relief (treatment usually being directed toward a correction of his diet). Following an examination one month before consulting us, he was told that his appendix was on the left side, but that it had no bearing on his condition.

The physical examination revealed nothing of special interest, except the fact that he was greatly reduced in weight, his weight at the time being eighty-seven pounds, with a height of five feet, four inches. The entire abdomen was more or less spastic to palpation, but there were no special points of tenderness and no masses were felt. Examination of urine was negative, and repeated examinations of his stool were negative for intestinal parasites, or evidence of pancreatic insufficiency. Blood examination was negative, except for evidence of a mild secondary anæmia. His blood Wassermann was negative. X-ray and fluoroscopic study done July 18, 1928, showed the stomach to be normal. The colon, as shown in Fig 1, was as follows: "Twenty-four-hour examination shows meal in colon from cæcum to rectum, with some residue in terminal ileum, which appears to be adhered on the right side, just above the



FIG 1.—Non rotation of the entire colon. Fluoroscopic study shows the cæcum, ascending and transverse colon adhered together.

crest of the ileum. The terminal ileum seems to be emptying into the cæcum from the right side. The entire colon is to the left of the median line, and the cæcum, ascending, transverse and descending colon appear to be adhered together. The appendix is patulous and appears to be fixed in the mid-line."

*Impression.*—In view of the fact that patient had had adequate medical treatment without any appreciable improvement; that repeated stool examinations were negative and that there was definite fluoroscopic and X-ray evidence of an anomaly of the colon, it was reasoned that the condition might be mechanical, and could probably best be dealt with by an attempt at correction of the anomaly.

Operation under gas-ether anæsthesia, July 23, 1928. Through a long right rectus incision, the abdomen was opened and the condition found was as described in Fig. 2.

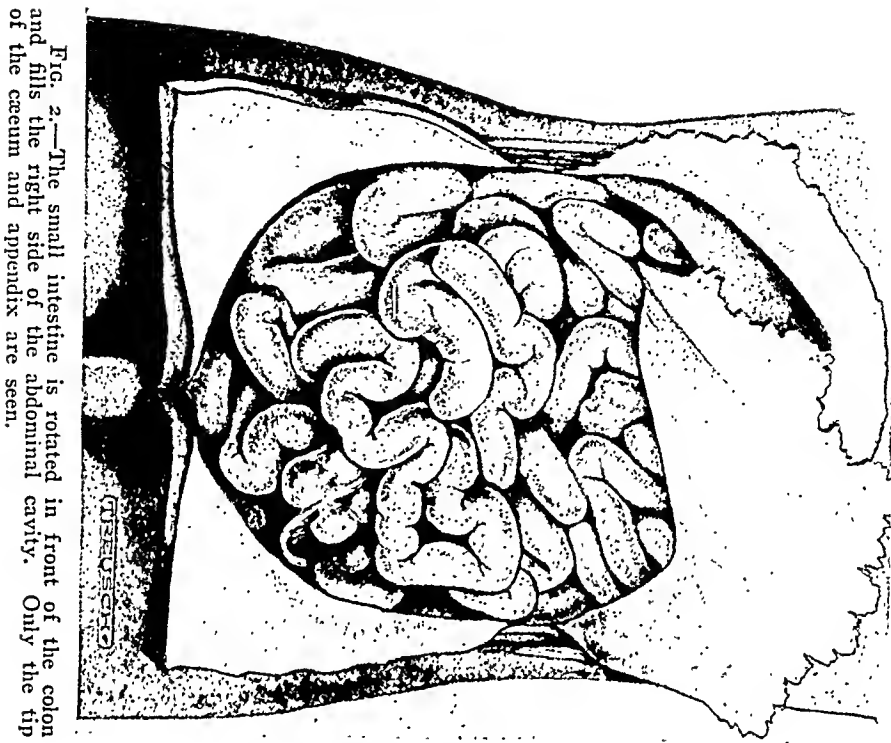


FIG. 2.—The small intestine is rotated in front of the colon and fills the right side of the abdominal cavity. Only the tip of the caecum and appendix are seen.

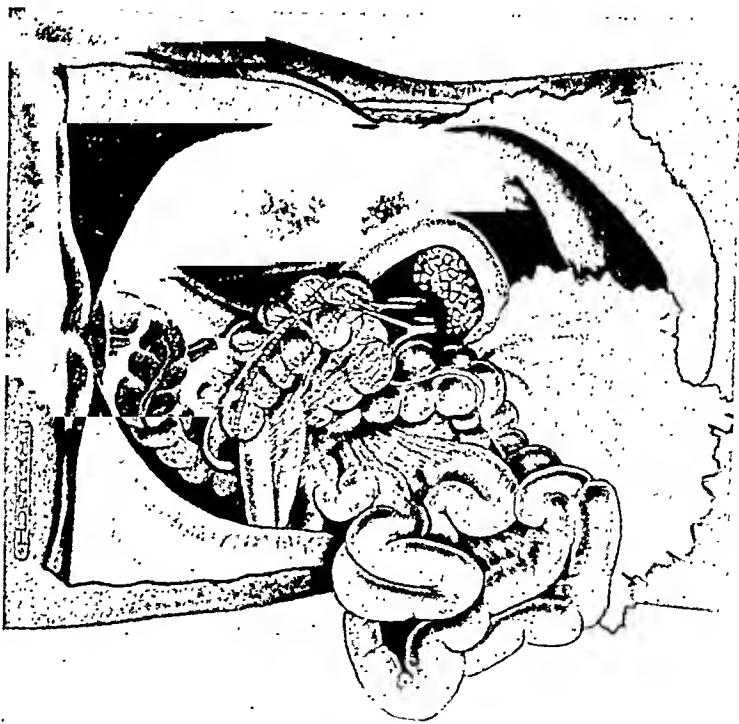


FIG. 3.—The small intestine has been rotated to the left, exposing the caecum, ascending, and a portion of the transverse colon. This is to the left of the median line, and is adhered together, and to portions of the jejunum and ileum by bands of adhesions. This portion of the colon is without a mesentery. The duodenum and head of the pancreas have no peritoneal covering.

There was a partial non-rotation of the transverse, ascending colon and cæcum, and with the exception of the cæcum, the colon was hidden from view by loops of the small intestine which had rotated in front and to the right, filling the right side of the abdominal cavity. When the small intestine with its mesentery was rotated to the left, the cæcum, ascending colon, and part of the transverse colon was found to be firmly adhered, by a thin membrane, to the duodenum and portions of the jejunum, and was without a mesentery. Its blood supply was derived from a large artery and vein which appeared to correspond to the mesenteric vessels. They came off directly from the abdominal aorta and inferior vena cavae, making contact about the middle of the transverse colon. They coursed along the transverse, ascending colon and cæcum close-adhered to the bowel, giving off arterial and venous branches. We were very confused and uncertain as to the nerve supply, but in the absence of a mesentery, it was assumed that the nerves accompanied the vessels, and had the same distribution. A portion of the duodenum was entirely extra-peritoneal, as shown in Fig. 3.

It was seen readily that the anomalous vessels were of sufficient length to allow the colon to be rotated to its normal position, provided it could be successfully freed from the duodenum and loops of small intestine. This was eventually accomplished; after which the colon was rotated into its normal position, and a colopexy was done (Coffey's technic). Following this, the raw surfaces were repaired and the abdomen closed in layers with one cigarette drain placed in the right iliac fossa.

*Post-operative Course.*—For the first seventy-two hours following operation, tympanites was very troublesome, but with this exception convalescence was uneventful. The wound healed without infection, and he was dismissed from the hospital on the twentieth post-operative day.

*Subsequent Course.*—Since operation, which is now approximately one and one-half years, patient has steadily gained in weight, and now weighs 138 pounds. He has had no return of abdominal pain or attacks of diarrhœa. An X-ray study of his colon, done September 9, 1929, shows meal in colon from cæcum to rectum. A part of the barium meal has been evacuated. Cæcum and ascending colon are in their normal positions on the right side of the abdomen; no pathology is demonstrated.

*Comment.*—From the operative findings and from the subsequent course of this case, it is fair to assume that the diarrhœa was due entirely to mechanical causes. As soon as peristalsis was set up in the duodenum and jejunum, following the intake of food, there was sufficient irritation produced in the cæcum, ascending and transverse colon to precipitate the evacuation of the bowels, resulting in the peculiar attacks of diarrhœa which always followed his meals.

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## ACUTE PRIMARY ILEOCOLIC INTUSSUSCEPTION IN THE ADULT

THE rarity of acute primary ileocolic intussusception in the adult warrants the report of this case. It is distinctly a disease of infancy or childhood; over 80 per cent. occurring during the first two years of life and less than 5 per cent. after puberty, and of this 5 per cent. practically all have been due to tumors or foreign bodies within the lumen of the gut, or were of the chronic or recurring type. In a review of the literature only three cases of acute primary ileocolic intussusception in middle life were found.

## ILEOCOLIC INTUSSUSCEPTION IN THE ADULT

It is probable that it is sometimes overlooked because of its infrequency. Missing the opportunity of seeing the patient at the onset, failing to diagnose early, and to operate immediately thereafter, results in a fatal outcome. Gangrenous areas of the intestinal mucosa produce toxins which affect the cells of the central nervous system, absorption of sufficient amounts producing death within five or six days. The real danger is the delay of prompt surgical intervention.

CASE REPORT.—B. H., fifty-three years, male, white, married, road supervisor. Family and personal history negative. Habits regular. No history of any previous attacks of colic, or indigestion. Healthy, industrious, outdoor worker. While supervising road building, had sudden, severe pain in mid-abdomen at 2:00 P.M., June 22, 1929; immediately vomited food eaten two hours before. This was his usual dinner and had not hitherto disagreed with him. He was rushed to the nearest physician two miles away, who administered a hypodermic of morphine, and as no relief was obtained from the paroxysmal pain, repeated the hypodermic in thirty minutes. When these had failed to relieve him, he was hurried in an automobile to Selma twenty miles away. The vomiting was relieved after the hypodermics, but the severe abdominal pain, lasting from five to ten minutes, recurred at approximately thirty-minute intervals. When he

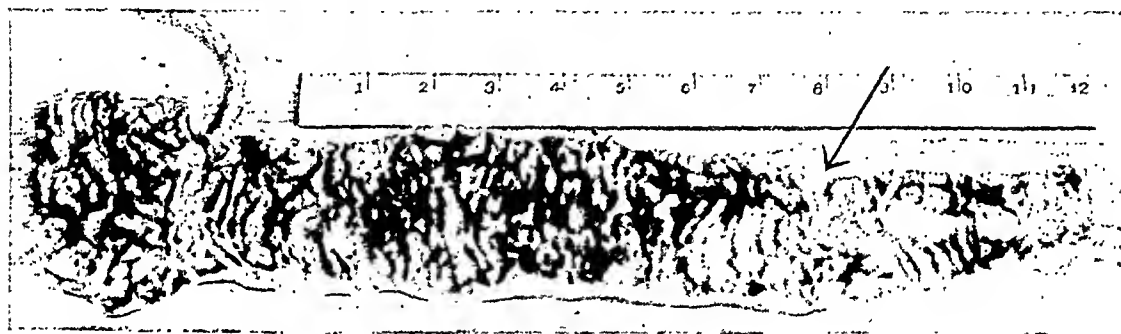


FIG. 1.—Mucous surface of resected gut. Arrow points to small enlarged Peyer's gland.

arrived in Selma, he was seen immediately by a physician, who gave him a hypodermic of morphine, and an enema, which was followed by a good bowel movement but with no abatement of his recurring paroxysms of pain. He was seen by my associate, Doctor Doherty, seven and one-half hours after the onset. At that time, his appearance was rather typical of acute appendicitis, as this visit found him in the interval between his paroxysms of pain. His abdomen was rigid; moderately tender on pressure over the right iliac region; absence of tumor or mass on deep palpation, complaining of nausea but no vomiting; pulse 80, temperature 97. The three hypodermics of morphine doubtless had masked the symptoms. Immediate operation was advised and he was admitted to the Vaughan Memorial Hospital two hours later, arriving in a paroxysm of severe abdominal colic, crying out noisily from the pain, for which a hypodermic of morphine  $\frac{1}{8}$  of a grain, and hyoscine  $\frac{1}{300}$  of a grain was given.

Physical examination at this time showed a well-nourished man, shocked, pale, perspiring and suffering intensely. There was general abdominal rigidity with distention, no intensification of pain on pressure over McBurney's point, but on deep palpation, beginning in the upper right iliac region and extending along the ascending colon, a mass could be detected in spite of the abdominal rigidity. The physical examination was otherwise negative. The blood count showed: Hæmoglobin 80 per cent.; red blood cells 4,200,000; white blood cells 13,300; polymorphonuclears 60 per cent.; small lymphocytes 24 per cent.; large lymphocytes 10 per cent.; eosinophiles 2 per cent.; transitionals 4 per cent. The urine examination was negative.

The presence of a mass this early after the onset of symptoms with recurring parox-

ysmal pain unrelieved by a grain of morphine given hypodermically in divided doses; the subnormal temperature, evidence of shock, an increased leucocytosis with a low polymorphonuclear count was not so characteristic of appendicitis as of intestinal obstruction. Additional evidence was obtained from a rectal flushing, the water returning clear containing a quantity of mucus, which, however, was not blood stained. A pre-operative diagnosis of intestinal obstruction was made.

At midnight the operation was begun under local anæsthesia; the abdomen was opened through a right gridiron incision rather higher than usual for an appendectomy; the mass was exposed and the appendix found with considerable difficulty, its base being pulled into the cæcum and the terminal ileum over-riding it; on inspection the appearance was that of a retrocolic hernia. By enlarging the abdominal incision upward, the true condition was demonstrated, as the ileum was seen to be invaginated along with a portion of the cæcum into the ascending colon. In attempting reduction by traction on the invaginated intestine, the pain was so intense that it was found necessary to etherize the patient. The force of the traction necessary to reduce the invagination was so great, even with manipulation from above, that it was feared the gut would be pulled in two or torn. The intussusception consisted of 16 inches of the terminal ileum, with a portion of the cæcum including the base of the appendix; the gut was dark with many thrombotic areas. The terminal ileum and cæcum were almost black in color. No gross pathology was observed in the examination of the reduced intestine. An enlarged Peyer's gland was in the ileum, more than one inch above the invaginated portion. The application of hot gauze pads for fifteen minutes was not followed by sufficient restoration of circulation to justify leaving the gut within the abdomen, as evidently portions of it would become gangrenous and slough. A resection was done, including all the darkened portion of the bowel consisting of the cæcum and 16 inches of the terminal ileum, including the appendix. A lateral anastomosis was made between the ileum and ascending colon  $2\frac{1}{2}$  inches above the point of resection of the cæcum. As a measure of additional safety, an enterostomy was done after the Mayo-Long method in the ileum, about 10 inches from the point of anastomosis; the abdomen was closed without drainage. Five hundred cubic centimetres of 15 per cent. glucose in a physiologic salt solution was given intravenously while the patient was still on the operating table. He was returned to his room, pulse 92, respiration 16, and was given immediately a clyster of 1 quart of plain hot water, which he retained. This was repeated after rectal flushing every six hours. The intravenous glucose was again given in seven hours, at which time his pulse was 90, respiration 20, temperature 98.3. He voided 6 ounces of urine, and thereafter in sufficient quantities. Rectal flushings returned colored and with lots of flatus; drainage from the enterostomy tube was free, temperature varying from 99 to 101.5. General condition continued very satisfactory, except that his skin was cold and clammy, with rather free perspiration, till the evening of the third day, a sudden severe pain in his abdomen and hiccough became persistent. The morning of the fourth day, he complained of a sense of fullness, his upper abdomen being markedly distended. On introducing a stomach tube, 2 quarts of coffee-colored fluid was withdrawn; two hours later he vomited a quantity of dark liquid. Peristaltin and pituitrin were given hypodermically, clysters of epsom salts, repeated gastric lavage, flushing of enterostomy tube and rectum, all without resulting improvement; the acutely dilated stomach, progressive ileus, and an extremely sick man caused us to do a second and higher (jejunal) enterostomy on the left mid-abdomen. Following this, the dilated stomach and ileus disappeared, the hiccough stopped, an abatement of symptoms with very free drainage of intestinal contents through the recent enterostomy opening; the improvement was temporary; he began losing from the excessive drainage through the high enterostomy opening, progressive and rapid emaciation ensued. The left enterostomy opening was closed after draining two weeks. His recovery from the profound inanition and attendant neurosis was very slow. His hospitalization lasted eleven weeks. The progress to complete health at the time of this report is gratifying.

## ILEOCOLIC INTUSSUSCEPTION IN THE ADULT

*Pathological Report.—Gross Description.*—The specimen consists of a strip of intestinal wall 3 centimetres in length, 0.8 centimetres in greatest thickness.

*Microscopic Description.*—Sections show small intestine with a large mass of lymphadenoid tissue extending from the mucosa to lower submucosa. The mass consists of many more or less distinct follicles so that the structure is that of a Peyer's patch. The central germinal region of the follicles is well preserved in most cases, but its cells are large and there is not the usual differentiation of cortical and central germinal-cell types. The supporting fibrous tissue columns are diffusely infiltrated by many large cells of lymphoblast type. Both here and within the follicles there are many mitotic figures. There are frequent large-cell forms but no cells of the Reed type. The lymphoblastic cells extend irregularly through connective tissue about the base of the lymphadenoid tissue. With them are many plasma cells and eosinophiles. There is slight fibrous tissue increase at this zone. A few cells extend also into the muscular layer and reach the serosa. There are occasional small interstitial hæmorrhages and occasional cells contain granules of blood pigment. The mucosa is hæmorrhagic and over middle of tumor mass it is ulcerated.

The lesion may be regarded as early lymphosarcoma. The numerous mitotic figures present may be only an inflammatory phenomenon but their distribution leads one to regard them as evidence of malignancy (Graham). *Microscopic Diagnosis.*—"Lymphosarcoma of Intestine." "The condition is one of a lymphosarcoma, which is not an unusual neoplasm to spring from the intestine."—(Lanford.)

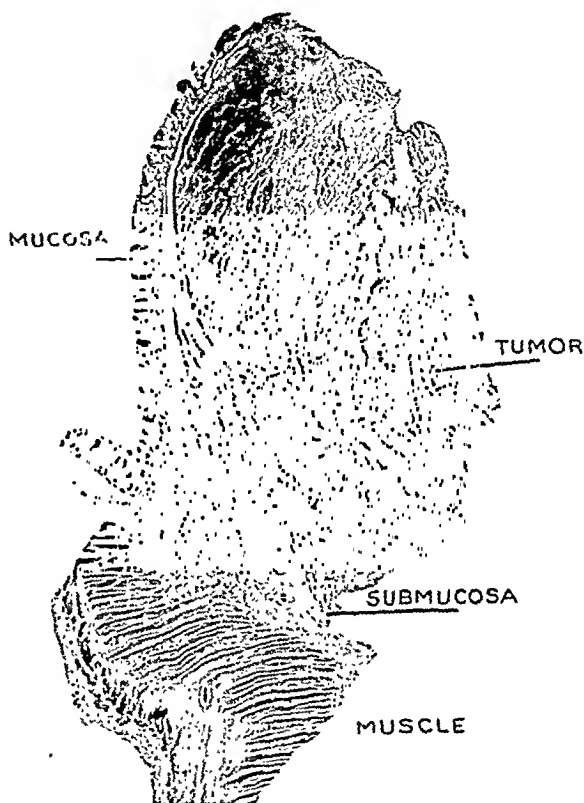


FIG. 2.—Passes through entire specimen showing mucosa covering the edge of the tumor, and below it the muscle. The section is cut on a tangent, and the relationship of the parts is thereby disturbed.

*Comments.*—Certain outstanding procedures appear to have been essential in the successful outcome of this case. 1. Early diagnosis and operation ten hours after onset. 2. Resection of traumatized and toxin-forming intestine, including unsuspected sarcoma of Peyer's patch. 3. The two enterostomies, one in the ileum at the time of operation; the second in the jejunum, after the onset of acute dilatation of the stomach and ileum. 4. Closing the second high enterostomy opening when progressive and rapid inanition became apparent. 5. Intravenous saline and glucose given repeatedly, combating dehydration. 6. Frequent flushings of the intestine through rectum and enterostomy tube removing toxic contents. 7. Repeated gastric lavage to avoid and to relieve dilatation. 8. Had the invagination been reducible and viable, the unsuspected sarcoma would never have been detected.

*Résumé of Cases Previously Reported.*—In the review submitted, only three cases of acute primary ileocolic intussusception were found among those reported.



## BRIEF COMMUNICATIONS

Two by Mooro' in 1924. These were Mohammedans and both had their onset following a religious fast of sixteen hours. The first, aged forty years, after drinking a glass of water had severe colic and four days later was admitted to the hospital with intestinal obstruction and peritonitis; operation revealed irreducible ileocolic intussusception. Resection, enterostomy, and peritoneal drainage was done; the patient died in twelve hours.

The second, aged sixty years, had violent colic while preparing his meal following the fast. He was admitted to the hospital five days later; operation revealed ileoileal intussusception, which had passed through the ileocaecal valve, forming an ileocolic intussusception. This was reducible. After reduction, gangrenous patches were found and a perforation at the proximal margin of the constricted ring of the ileum, as a result of gangrene. Resection, enterostomy, and peritoneal drainage was done. The patient died six hours later. In both cases, examination of the resected gut and of the rest of the intestines, at autopsy, revealed nothing in the nature of a tumor of the intestinal wall or of a swelling of Peyer's patches. The length of the invaginated gut was 2 feet



FIG. 3.—The high magnification of the tumor cells surrounding the mucous glands.

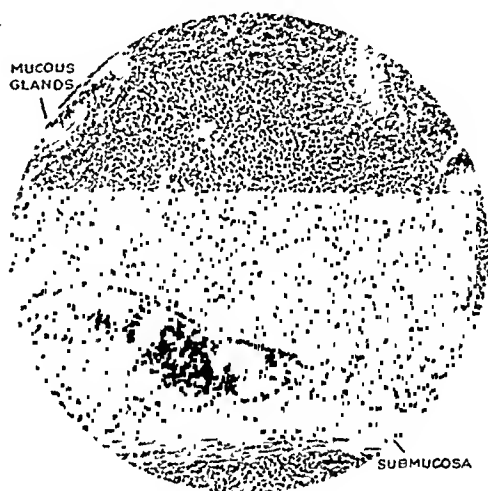


FIG. 4.—Tumor nodule in the mucosa, there being noted mucous glands on the surface completely surrounded by growing tumor, which is infiltrating into the submucosa.

in the first and 3 feet in the second case. The remarkable example of the influence of the mind on the motor function of the intestine is emphasized in this report.

The case of Hinton was a man aged thirty-two years. Immediately after eating a piece of cake, he had severe pain, and was admitted to the hospital twenty-four hours after his attack; he gave a history of recurring attacks of abdominal pain, similar to this but less in intensity. On operation, a six-inch intussusception of the ileum, appendix and caecum was found and reduced. The appendix was removed and the abdomen closed without drainage. No other abnormality of the abdominal viscera was found. The recovery was uneventful.

A study of the literature shows that almost all of the adult cases of intussusception were caused by a tumor, usually pedunculated, within the lumen of the bowel. As a result of peristaltic waves the tumor pulls on the portion of the intestinal canal at the point of attachment, and this disturbance produces a spastic contraction of the bowel over the tumor, and as in spastic conditions of the intestine proximal to the area of contraction, there is an area of relaxation. The downward force of the peristaltic wave pulls a

segment of the gut into this relaxed area and thus begins intussusception due to tumor. A study of the cases where no gross pathology of the intestine is found has given rise to the opinion that vasomotor disturbances reflex in origin, producing spastic and relaxed areas proximal to each other, are the probable causes of primary intussusception. In the three cases in adults herein reviewed a reflex vasomotor disturbance originated in two from the intake of food, and in one from the stimulation of the appetite while preparing food. It is a question whether the one here reported is due to the intake of food two hours prior to onset, or the most probable conclusion from the lymphosarcoma situated in a Peyer's patch. Had this sarcomatous structure been included in the invaginated part of the gut, such a conclusion would be most rational. The fact that it was over an inch above the invaginated segment would cause one to doubt as to whether it was coincidental or causal. The fact that these sarcomata frequently are of very rapid growth would cause one to lean to the hypothesis that this rapidly growing tumor, infiltrating into the muscular coat, caused reflexly areas of spasticity and dilatation; on the other hand the element of doubt enters again as lymphosarcoma is commonly found in this portion of the gut; whereas intussusception in adults is of extraordinary rarity. The fact remains that from either, or both, could come the stimulus of reflex spasticity and relaxation causing intussusception. The symptoms are essentially those of mechanical obstruction, the outstanding feature being sudden and unusual severity of pain at the onset; intermittent in type, accompanied with shock and even collapse, nausea and vomiting, and bowel evacuation without consequent relief of pain. Tumor at the very onset may be absent, but manifests itself as a definite mass within a few hours, appearing much earlier than masses found in attacks of acute appendicitis.

*Causes of Death.*—"Cannot be ascribed to one factor."

A. Intrinsic. 1. Toxicity of bowel contents above obstruction. 2. Gangrene of obstructed portion with absorption of autolytic and bacteriologic products which exhibit a high degree of toxicity. 3. Dehydration more intense the higher the obstruction.

B. Extrinsic. 1. Procrastination in summoning a doctor. 2. "The tragedy due to late diagnosis." 3. Delayed operation. 4. Inadequate surgery. 5. Insufficient supportive and eliminative treatment following operation.

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## A FASCIA-CHECK BAND FOR RELIEF OF PARALYTIC GENU RECURVATUM\*

THE genu recurvatum produced by relaxation or paralysis of the structures on the posterior aspect of the joint is a disabling as well as an unsightly deformity.

A moderate degree of hyperextension at the knee may be corrected by an osteotomy of the femur or tibia, but in the more severe types of paralytic genu recurvatum the osteotomy has the disadvantage of requiring, in order to render it mechanically effective, a greater degree of bony angulation than one desires. So that if the patient with severe hyperextension at the knee desires to retain mobility at the joint, he has ordinarily been fitted with a jointed brace or motion has been sacrificed for stability and arthrodesis performed.

In an attempt to obviate the necessity of using either of these latter methods of treatment, which have obvious disadvantages, it was thought that



FIG. 1.—Showing degree of genu recurvatum before operation.

a rolled fascial strip from the strong fascia covering the outer aspect of the leg might be used to act as a check ligament to prevent hyperextension. Therefore, a strip of fascia about an inch and a half wide was dissected up from the fascia on the outer aspect of the leg and rolled in such a manner as to keep the muscle side out. Then the shaft of the femur was exposed several inches above the joint and this rolled fascial ligament inserted subperiosteally and brought down on the inner side of the knee under the hamstring muscles and imbedded in the posterior internal surface of the tibia.

It was thought that the tendency of this fascial-check ligament to stretch under weight bearing would be minimized if it were secured at the three bony points of contact, head of fibula, shaft of femur, and postero-internal surface of tibia. This method has been done several times on cadavers but upon only one living case and it is realized that no definite conclusions can be made, but the procedure is presented for your consideration. One can, however, say that the deformity in this case, which was done over a year ago, has not recurred under weight bearing, and this in spite of an active quadriceps

\* Presented before the alumni of the Hospital for the Ruptured and Crippled, November 26, 1929.

## RELIEF OF PARALYTIC GENU RECURVATUM

muscle, and in spite of the extra strain that has been put on the posterior structures of the knee by the foot being in an attitude of equinus following astragalectomy. The history made on admission to the New York State Reconstruction Home in 1928 was as follows:



FIG. 2.—Post-operative photograph showing stability of the knee when the patient is standing on the left leg.

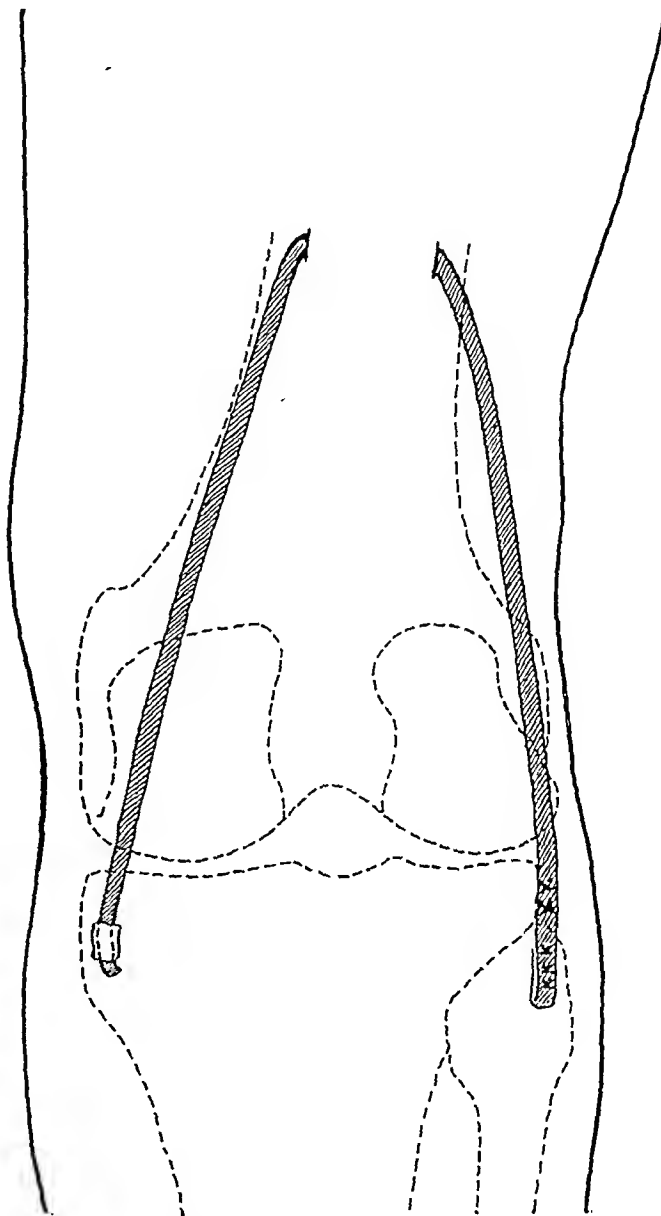


FIG. 3.—Diagram showing the folded strip of fascia attached to the head of the fibula, shaft of the femur, and the condyle of the tibia.

This patient is fifteen years of age and gives a history of having had infantile paralysis at the age of three, which involved both lower extremities. Examination shows that she is in good general condition, presenting no paralysis other than that of the left lower extremity.

She is unable to walk without being supported and presents atrophy of the entire extremity and recurvatum at the knee. On the left side the iliopsoas muscle is paralyzed, the other flexors of the hip appear weak but active. The abductors and adductors appear to be paralyzed. The gluteal extensors are active. The left knee assumes an attitude of extreme recurvatum whenever weight is borne. The quadriceps

is weak but the patient is able to actively extend the knee against gravity. There appears to be no power in either group of hamstring muscles. Below the knee the foot is in an attitude of calcaneo-valgus and all the muscles appear paralyzed with the exception of a trace of power in the flexor of the big toe.

On November 7, 1928, this patient had an astragalectomy operation performed on the left foot for calcaneo-valgus. On November 30 the fascial-check operation was performed as follows:

The entire left limb was prepared in the usual manner and the operation performed without a tourniquet. A long incision was made on the lateral aspect extending from a few inches above the knee-joint down to the lower third of the leg, and another incision on the medial aspect extending a few inches above and below the knee-joint. A broad fascial strip from the lateral aspect of the leg was dissected upward. The length of this strip was determined by making it slightly more than twice as long as the distance from the head of the fibula to the subperiosteal tunnel on the shaft of the femur as shown in the diagram. This fascial strip was then carefully rolled, folded upon itself at the level of the head of the fibula and several kangaroo sutures inserted at this point as seen in diagram. Then the rolled fascia was directed subperiosteally across the femur and brought down under the hamstring muscles after which it was sutured to the tibia, while the knee was kept flexed at an angle of about 160 degrees. The wound was then closed in layers and plain catgut used for the skin. Plaster-of-Paris casing applied, extending from the ankle to the groin with the knee remaining in slight flexion.

The wound healed per primam and the patient wore this plaster support six weeks following operation, after which all support was removed from the knee and weight bearing allowed. The security of the joint one year after operation is shown in the photograph while the patient is bearing the entire weight of the body on the left foot.

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### PAPILLOMA OF THE DUODENUM\*

NEW growths of the duodenum are a most infrequent finding. Balfour and Henderson<sup>1</sup> in a recent paper on benign tumors of the duodenum were able to gather the records of 131 benign growths, so seemingly the mucosa or the secretions have the singular power of restricting the growth of neoplasms. Golden<sup>2</sup> in a collective review of papillomata of the duodenum was able to assemble the reports of but seventeen cases and added two of his own, bringing the total number to nineteen. The case of benign papilloma reported in this paper is a typical example of a pedunculated papilloma which manifested its presence by severe and repeated hæmorrhages and closely simulated an ulcer.

CASE REPORT.—No. 49-951, a woman, age thirty-nine, married, was admitted to my care at Lebanon Hospital October 14, 1925, with the history that about two years ago

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\*From the surgical service of Lebanon Hospital of New York.

## PAPILLOMA OF THE DUODENUM

she began to complain of heartburn which was more or less constant, belching of gas, excessive gas passed per rectum and a feeling of distress in the left lower quadrant, most annoying about four hours after a meal. This uncomfortable feeling was relieved by the taking of bicarbonate of soda and the belching of large quantities of gas.

These attacks would persist for a few days with intervals of complete relief of from one to three weeks and have been progressively getting worse and lasting longer. During all this time the patient has been feeling very weak and tired and constantly falling asleep even while at the theatre.

During the past five weeks the patient noticed that her stools were very dark in color, at times almost black. About two weeks ago the patient became so weak that she went to bed and has remained in bed up to the present time. During the past week she has complained of severe cramp-like pains in the calves of the legs. Has lost six pounds in weight. No vomiting or nausea.

*Past history.*—Essentially negative. Has never been pregnant.

*Examination.*—Skin and mucous membranes markedly anæmic. Head, neck and chest essentially negative. The abdomen is rounded and muscles move easily with respiration. On light palpation there is very slight muscular spasm in the left lower quadrant and some spasm but less marked in the right lower. There is practically no spasm of the muscles in the upper half of the abdomen. Slight pain is complained of when the hand is passed over the lower half of the abdomen but not in the upper half. Blood pressure, 116/78; Wassermann negative; blood group, Type 1 (Jansky). Urine negative. Stools positive for blood +++++, macro- and microscopically. Coagulation time, five minutes; bleeding time, three minutes. Temperature from 99° to occasionally 102° at night; pulse soft, ranging from 90 to 120; respiration 20. Hæmoglobin 30 per cent. (Dare); red blood cells 2,152,000; white blood cells 6,400; platelets 365,000; differential count—Polymorphonuclears 56, lymphocytes 44.

All the usual conservative methods were tried to stop the bleeding with the idea of allowing the patient to recover sufficiently to have a thorough X-ray examination of her gastro-intestinal tract made in order to establish by this means if possible the source of the bleeding. Everything was interdicted by mouth and the patient coöperated with us even to the extent of not swallowing her saliva. Fluids were given under the skin and glucose solution was absorbed in fairly large quantities per rectum. As the days went by the amount of blood passed per rectum diminished but was always present.

October 19, or five days after her admission, due to her continued passing of blood per rectum the hæmoglobin dropped to 20 per cent. and the red cells to 1,400,000. As the bleeding still continued a transfusion of plus 500 cubic centimetres was given by the direct method October 30 and the same amount was given November 5 and November 24.

As the patient was not gaining, in fact she was losing ground by the conservative treatment, it was decided to perform a probative laparotomy. The only definite thing to guide us in the absence of X-ray evidence was the presence of blood in her stools and its thorough admixture with the stool. This pointed to a lesion very high up in the gastro-intestinal tract and as she did not vomit we reasoned that the lesion was distal to the pylorus. The commonest lesion in this region to give bleeding was an ulcer of the duodenum and with this as a tentative pre-operative diagnosis she was prepared for operation for November 25, 1925.

As already stated a transfusion of plus 500 cubic centimetres of blood was given by the direct method. After a wait of two hours to be sure that no reaction followed, the abdomen was opened under novocain block anaesthesia through an upper right rectus incision. The peritoneum was opened without the escape of any free fluid. The stomach and intestines were found to be markedly anæmic and the former was easily drawn into the wound and thoroughly examined but found to be negative. The duodenum was more fixed and only the first portion could be mobilized. On the anterior aspect a small area was identified as a duodenal ulcer; this was thickened and the peritoneum

## BRIEF COMMUNICATIONS

over it on rubbing showed marked stippling. Palpation of the remaining parts of the duodenum as far as was possible with this form of anaesthesia, though limited, was negative. This fact is noteworthy in view of the later findings. We decided to explore the duodenum and excise the small thickened area. An incision was made in the duodenal wall beginning about one inch distal to the pylorus and carrying the incision through the pylorus on to the wall of the stomach for a distance of about two inches, this incision being planned so as to come just to one side of the thickened area and to make its removal a simple procedure. On inspecting the duodenum through this opening nothing else was found except that the site of the thickening of the duodenal wall showed ulceration on the mucous membrane, so this area was excised. Further examination showed nothing abnormal. The closure of the bowel and stomach was done as in a Horsley or Heincke-Mikulicz operation with chromic catgut in three layers. Abdomen closed in layers.

The post-operative convalescence was uneventful and the stools were negative for blood after the first few days and the patient gained in strength. She was discharged December 10, 1925.

The pathological report of the excised ulcer showed "small round-cell infiltration in mucosa and submucosa. At one area there is a gradual destruction first of the superficial glands and then of the deeper glandular structures. This defect is filled in with small round cells and connective tissue."

The patient was seen in March, 1926, and had gained about fifteen pounds in weight. She still complained of some distress with distention after eating but otherwise felt and certainly looked well. She was advised to have an X-ray examination made at this time which was done and except for the distortion of the pylorus it was reported negative.

January 9, 1927, or about thirteen months after her operation, the patient came to see me with the story that she had been bleeding again for about a week and had tarry stools as before the first operation. She was sent to the Lebanon Hospital where her haemoglobin was found to be 48 per cent.

The problem as to what to do for the patient was indeed a serious one. At the previous operation there was still an element of doubt as to whether the small ulcer that was excised had been the actual cause of her having lost the large amounts of blood from her bowel, but the fact that following the operation and for over a year there had been no bleeding was definite evidence that whatever had been done at the first operation was seemingly the cause of the cessation of bleeding. At least it was logical to infer that such was the case. The fact that only the first portion of the duodenum lent itself to thorough examination at the operation under block anaesthesia was a point that left us with the thought that there might be a pathological lesion at a point lower in the bowel but still in the duodenum; the lesion still was considered a possible ulcer that was not palpated at the first exploration, unsatisfactory as it was. In order that no more time would be lost and before the bleeding would lower her haemoglobin to such a point that a general anaesthetic would again be contraindicated it was suggested to the patient that an exploration be done at an early moment under gas-oxygen-ether anaesthesia. The patient accepting this, she was prepared for operation January 13, 1927.

The old scar was excised and the peritoneum opened with no escape of fluid. After freeing the pylorus from a few adhesions the stomach was mobilized easily and found to be free from pathology. The pylorus was rather distorted as the result of the previous plastic but there was no thickening in any part of it. While this was inspected the descending portion of the duodenum was observed to be the site of an apparent intussusception and when the bowel was more closely inspected this was found to be the case—about one inch of the bowel was drawn within itself. At the lower part of the descending portion of the duodenum a mass about the size of a thumb was felt within the lumen of the bowel which was very freely movable. The duodenum in

## PAPILLOMA OF THE DUODENUM

this portion was drawn up and opened between traction sutures. This exposed a long papillomatous mass about 6 centimetres long and 3 centimetres wide, parts of which were actively oozing. The base was attached by a pedicle about 1 centimetre across to the posterior wall and upon exerting slight traction was seen to be attached to the mucosa. A few snips of the scissors freed it entirely and a row of chromic gut sutures repaired the rent in the mucosa where it was attached. The rest of the duodenum was normal. Three-layer closure of the duodenal wall followed but the bowel seemed somewhat constricted due to this and the previous operation so a posterior gastro-jejunostomy was done and the abdomen closed in layers.

Convalescence was uneventful and the patient was discharged cured January 28, 1927.

*The pathological report* was as follows: "Kidney bean shaped mass about 6 by 3 centimetres, firm and glistening, smooth on section and divided into small lobules by connective tissue bands. Section shows islands of adenomatous tissue separated by wide strands of connective tissue. There is infiltration with a moderate number of pus cells. No evidence of malignancy. *Diagnosis*.—Papillary adenoma with acute inflammatory reaction."

### REMARKS

The outstanding facts to be noted in this case other than the comparative rarity of this condition, is the insufficient opportunity afforded in exploring this portion of the bowel under local anaesthesia at the primary operation which did not allow the real source of the bleeding to be palpated. The papilloma we are convinced was present, but owing to its position in a rather fixed portion of the bowel could not be brought up to the palpating fingers.

The X-ray gives a fairly definite picture and should help in the diagnosis when it is obtainable. In the face of active and massive bleeding this might seem to be contraindicated but on careful analysis it seems to us that there is less danger in a well-administered barium meal than there is in exploring the abdomen rather blindly in the hope of finding the source of bleeding. Should the films and fluoroscopy not show the cause of the bleeding definitely, at least the site might be suspected and inspection primarily directed to this area.

Some papillomata have been found in the duodenum when the latter has been opened to remove an impacted calculus in the papilla of Vater and a few which sprang from the mucous membrane about the papilla gave symptoms of jaundice.

A résumé of the symptoms of this case and others reported will show that the outstanding features of this condition are blood appearing in the stools and well mixed with the food residue but without the definite concomitant clinical signs of ulcer, the commonest form of duodenal lesion. Occasionally there is associated with this condition some degree of jaundice.

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## A BONE EXTENSION CLAMP\*

For the open reduction of fractures of long bones, we know of no instrument which is more simple and effective than the Lane clamp. However, there are times when a leverage action in obtaining extension would be of considerable assistance. In designing the instrument illustrated we have tried to keep in mind simplicity and effectiveness.

Numerous instruments are on the market which undoubtedly facilitate reduction and maintain it while the internal splint is applied, but most of them require too much time in application and take up too much room in the operative field besides being very expensive.

We have taken two Lane clamps, modified them slightly by having a single tooth on each jaw instead of a double tooth, fastened a spring lock bar on

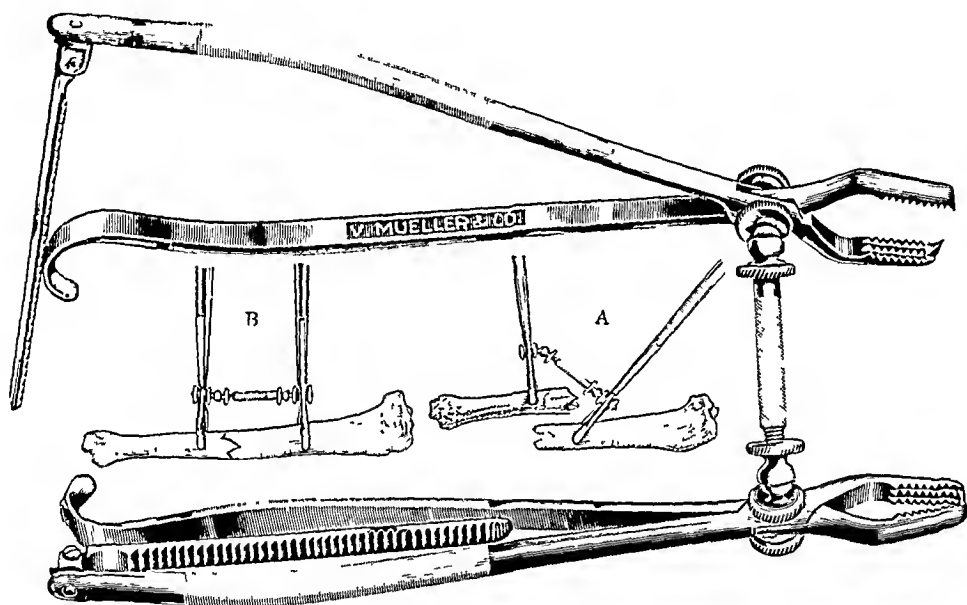


FIG. 1.—Clamps presenting single tooth; ball and socket joints; swivel fulcrum and lock bar. A.—Showing over-riding of fragments of bone held by clamps at an angle ready for extension. B.—Fracture reduced.

the handles and a fulcrum in the form of a turn buckle with a double ball and socket joint, between the box locks of the two clamps. The single tooth on the jaw of the clamp has the advantage of not tearing the bone and periosteum when extension is applied. For purposes of illustration, we will consider a simple transverse fracture. The upper fragment is grasped by one clamp at an angle of  $45^\circ$  with the handle of the clamp directed away from the fracture, the other clamp is applied to the lower fragment at the opposite angle. The clamps are then locked and the leverage action obtained by forcing the handles together.

This instrument is extremely flexible on account of the ball and socket joints and rotation can easily be accomplished. If a longer fulcrum is desired the swivel bolt is unscrewed, thus lengthening the fulcrum. With the use of

\* From the Jackson Clinic.

## DECOMPRESSION OF THE HEART

this clamp we are able to overcome any ordinary amount of over-riding. The fragments are easily held while the internal splint is applied and very little room is taken up in the operative field by the instrument. There is no necessity for coming in contact with the wound with anything but the jaws of the clamps. When the lock bars on the clamps are closed, the instrument will stay in position without being held by the operator.

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## DECOMPRESSION OF THE HEART

IN THE November, 1929, number of the ANNALS OF SURGERY several articles in honor of the Semi-Centennial Anniversary of the Philadelphia Academy of Surgery appeared. One of these was upon "Decompression of the Heart," by Dr. Evart Graham, of St. Louis, Mo.

Doctor Graham's well-recognized experience and ability in the surgery of the chest, as well as in other branches of surgery, may, I hope, lead physicians and surgeons to appreciate the advantages to be gained by early resort to decompression of the heart in suitable cases before the organ is worn out in its struggle to function in a too-narrow cage.

Although my own experience is limited to three cases in which the operation was primarily designed to untether a hypertrophied, much crippled heart by mediastino-pericarditis, yet, in a paper written in conjunction with Dr. A. D. Dunn,<sup>1</sup> of Omaha, we expressly stated, as Alexander Morrison<sup>2</sup> had advocated and practised the removal of several overlying ribs to allow the heart freer play in a case of cor bovinum, that "the freer play afforded the greatly hypertrophied and dilated heart by the operation was noted in our case. The correctness of Morrison's reasoning must be determined by extensive clinical application of this theory. We would suggest the term Cardiac Decompression in place of Thoracostomy as used by Morrison, because it better describes the import of the operation."

Those particularly interested in the subject may find the sphygmographic and cardiographic tracings made both before and after operation on this patient and other data from the literature in our paper. The man lived four and one-half years after operation and should perhaps be living today had we been able to control his habits and activities.

Further notes on this case and another may be found in *Surgery, Gynecology and Obstetrics*, July, 1917, pp. 92-95.

Doctor Graham noted in the technic carried out upon his patients that a sub-periosteal resection of the ribs was made as well as that the periosteum and perichondrium were stripped off the pleura. All of this I regard as essential in order to obtain the substitution of a soft tissue covering for the heart without the constant hammering of the chest wall. I would like again to state that in our paper we wrote: "The purpose of the operation was

not only to untether the heart by doing away with the costo-pericardial adhesions, but also to give the enlarged organ room for free play."

Doctor Graham's second case may possibly be considered as coming within the scope of pathology for which Morrison recommended operation—the child survived the operation three months. The first case can hardly be considered of that type, the early post-operative death (five months) and the autopsy findings would indicate great crippling of a much damaged hypertrophied heart.

The obliteration of both pleural spaces and that of the pericardial cavity by dense fibrous adhesions and the attachment of the pericardium to the thoracic wall, taken together with the findings of the heart walls and its cavities, scarcely place the first case within a class suitable for any surgical procedure.

"A chronic adhesive pleurisy, as is well known, becomes a factor of no little importance in a circulatory problem, in which the work to be done approximates the power available." (Dunn-Summers.) There are unquestionably "many inviting problems" to be considered when taking under advisement decompression of the heart. We will have to present better evidence of the advisability of operation, in embarrassed cardiac hypertrophy in particular, to induce physicians to change their usual management of the pathology of this important organ.

JOHN E. SUMMERS, M.D.  
*Omaha, Nebraska*

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Amer. Jour. Med. Sciences, Jan., 1913.
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#### GALL-STONES IN THE DUODENUM

THE report of the following case is offered for publication because: (1) of the absence of obstructive symptoms despite the fact that the duodenum was practically occluded by stones; (2) the lack of any fistulous opening, or a scar, between the gall-bladder and duodenum; (3) the rarity of similar cases reported in the literature.<sup>1, 2</sup>

The patient, a woman, age sixty years, was first seen by me September 24, 1928. For two years she had been suffering with symptoms indicating gall-stones. They were characterized by pain in the epigastrium radiating to the right shoulder; nausea and vomiting, associated with jaundice. Vomited often during and after these acute attacks. Tenderness and some rigidity over epigastrium. When first seen she seemed too ill to consider surgery. She remained under treatment for eleven days and was then discharged under the care of her family physician.

Two and one-half months later she returned to the hospital. She had had no attacks of severe pain since her previous admission although there was still some tenderness over the gall-bladder. No history of constipation. She had dieted for the two and one-half months because eating caused discomfort and some pain in the epigastrium. She had lost forty pounds, which she attributed to the diet, but her general

## METHOD OF CUTTING A SMALL DEEP GRAFT

condition was much improved; renal function at this time being 40-15-55, blood count normal, blood urea 14 milligrams, NPN 33.6 milligrams. Urine contained 20 milligrams of albumin but no casts.

She was observed for four days and operated upon on the fifth day, December 14, 1928.

Under ether anaesthesia upper right rectus incision was made exposing the pyloric end of the stomach, together with omentum, adherent to the gall-bladder. These adhesions were liberated and a very hard irregular mass was palpated in the first portion of the duodenum, immediately below the pylorus. One area the size of a ten-cent piece was very black. An incision was made just inferior to the pyloric sphincter, and ten moderately-sized gall-stones were removed from the first portion of the duodenum, where they had been tightly packed against the pylorus. Careful investigation was then made of both the gall-bladder and duodenum and there was no evidence of any fistulous opening, or of a scar, between these two structures. The duodenum was then closed in the usual manner. The gall-bladder was opened and one moderately-sized stone found in it was removed. Palpation revealed two stones in the common duct. The gall-bladder was split and an incision made into the common duct and the stones in the latter structure removed. One rubber tube was then placed in the common duct, the end pointing toward the liver; the common duct was sutured about the tube. A large portion, three-fourths, of the gall-bladder, was then removed and the remaining portion approximated around the rubber tube placed in the common duct. The usual accessory drainage was instituted. A portion of the omentum and peritoneal flap was then sutured over the incision previously made in the duodenum, thus affecting a complete peritonealization of this raw surface as well as reinforcing it. The incision was closed in the usual manner.

The patient entered an uneventful convalescence and left the hospital on the fifteenth post-operative day. At the present time she is well, has no complaints and is able to pursue her household duties.

PAUL D. SCOFIELD, M.D.

*Columbus, Ohio*

*From the service of Dr. R. B. Drury at the Grant Hospital.*

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## THE SMALL DEEP GRAFT

IN AN article on "The Small Deep Graft" published in the ANNALS OF SURGERY, June, 1929, page 902, the enlarged photographs used to illustrate the technic of cutting this type of graft did not reproduce as well as was expected. In consequence, there has been some confusion in following the legends and a number of inquiries have come to me about the matter. In order that the steps in the process might be made perfectly clear, Max Broedel has been good enough to make for me some excellent drawings which beautifully illustrate the procedure. These follow:

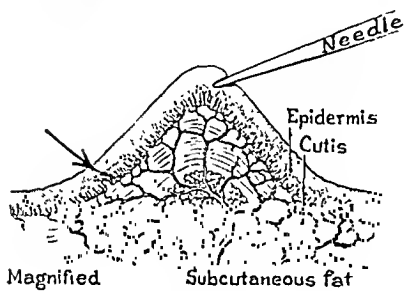
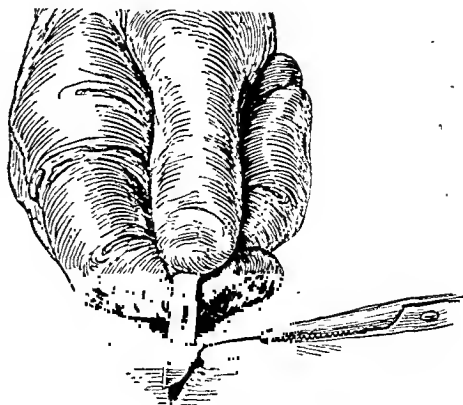
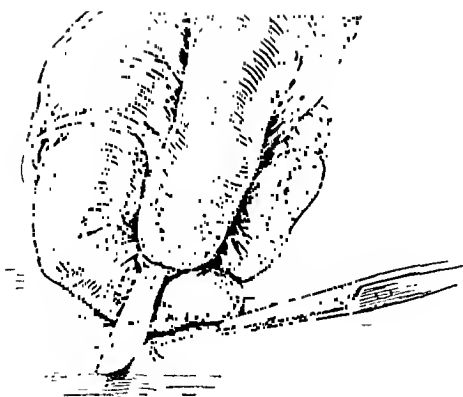


FIG. 1.

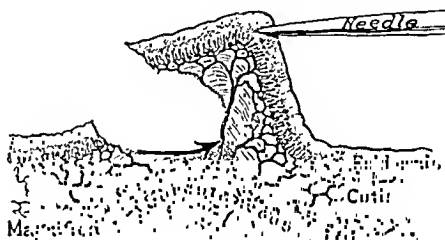


FIG. 2.

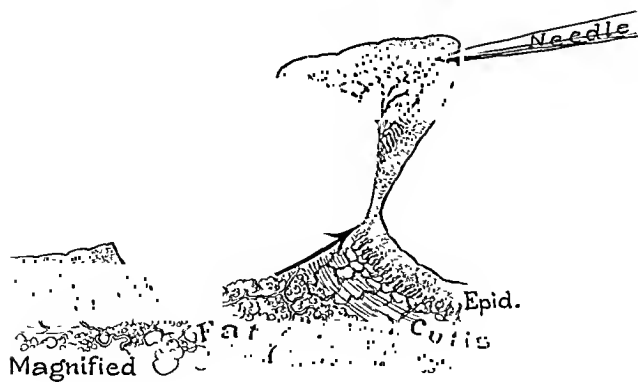
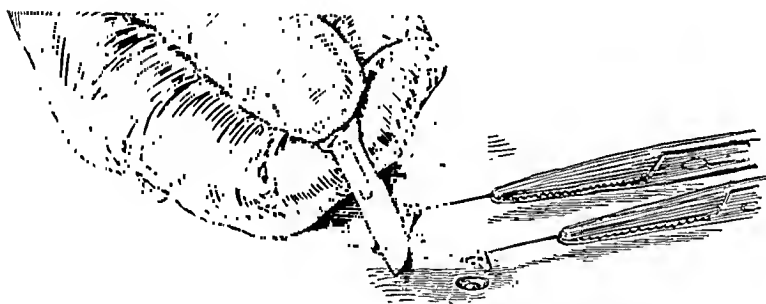


FIG. 3

## METHOD OF CUTTING A SMALL DEEP GRAFT

FIG. 1.—Shows the point of a needle held in an artery clamp lifting up a little cone of skin. Note the edge of the knife against the base of the cone with the blade tilted slightly downward.

The insert is a schematic drawing, magnified to scale, of the cone of skin raised by the needle. The black arrow indicates the direction and tilt of the blade in cutting through the first half of the base of the cone.

FIG. 2.—Shows the graft cut halfway through. The tilting of the knife blade downward as far as the center of the graft will usually include the full thickness of the corium at that point.

The insert is a schematic drawing, magnified to scale, which shows the details of the small deep graft cut halfway through the base of the cone. The black arrow indicates the upward tilt of the blade which begins at that point.

FIG. 3.—Shows the position of the knife blade tilted upward as it almost completes cutting the second half of the graft. It will be noted that the process in cutting the second half is reversed, the blade going from the thick center upward and outward to the thin margin.

The appearance of a graft after it is completely cut and still on the needle is shown. The

graft should not be more than .5 centimetre in diameter. The central portion is much thicker than the margins. Note the wound from which the graft is cut, especially the little area of fat which can be seen in the central portion of the pit, which indicates that the full thickness of the corium is included in the graft at that point.

The insert is a schematic drawing, magnified to scale, which shows the details of the process in cutting the second half of the graft. The black arrow indicates the upward and outward tilt of the blade at a point just before the separation is completed.

FIG. 4.—Showing the relative thickness of a Reverdin graft as compared with a small deep graft.

Schematic drawing, magnified to scale, which shows a cone of skin raised by a needle just as if a small deep graft were to be cut. In order to cut a Reverdin graft, the knife blade is held flat at the level through which the tip of the cone is to be cut across, and the direction and level is indicated by the upper arrow. In this way by cutting close to the needle the thinnest type of graft can be removed, and this is the true Reverdin graft. Note that only the epidermis and a portion of the papillæ of the corium are included. Compare the thickness of the Reverdin graft with that of the small deep graft, whose outline is indicated by the three black arrows.

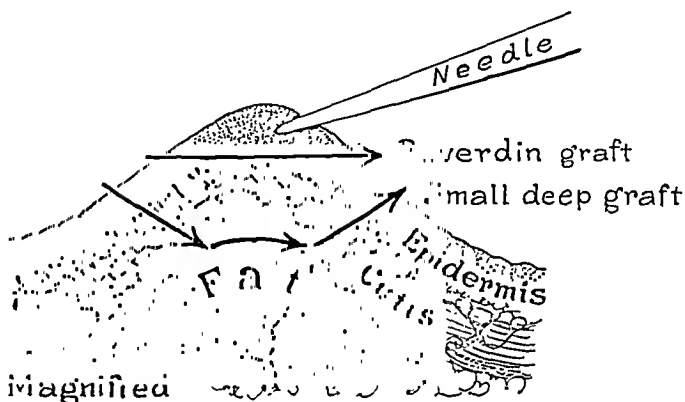


FIG. 4.

JOHN STAIGE DAVIS, M.D.  
Baltimore, Md.

# MEMOIRS

## THEODORE TUFFIER

1857-1929

A REVIEW of Tuffier's surgical activity is a complete history of the surgical art in the last forty years. At every stage we find the scholar, the innovator,



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THEODORE TUFFIER, M.D.

the teacher. Particularly did he comprehend the importance of experimental surgery.

His ancestry was fine old peasant stock. His talents and industry were obvious from the start of his medical career, Interne, 1879; Attending Sur-

geon to the Hospitals, 1887; and Professeur agrégé, 1889, when he immediately made a reputation as a brilliant teacher of external pathology. His hospitals were the Pitié, Lariboisière, and Beaujon. His services were a shrine for the surgical pilgrims from all over the world.

Among his notable achievements was his war record. From 1914 to 1918 he devoted all his activities to the war surgery, especially of the front. He became Inspector General of the Surgical Services of the Armies. He was particularly active in putting into force the Carrel method and later the excision of wounds. He was President of the French Section of the Interallied Surgical Conference of which he was one of the founders and to which he made a series of important reports on the problems of war surgery.

Tuffier's eminent services during the war were rewarded by the order of Commander of the Legion of Honor, and subsequently in 1925 by the Grand Cross and by the Croix de Guerre, with a citation at the order of the Army, "Surgeon of the highest accomplishments. Although not under any military obligations has given to the Armies from October, 1914, to the end of the war the coöperation of his science and particularly in the great military operations of Champagne, Verdun, Somme, Flanders, l'Aisne and the Marne." Grand Headquarters, February, 1919, Maréchal Pétain.

In 1925, the occasion of the Third International Congress of Medicine and Pharmacy, his former pupils and friends celebrated his jubilee under the Presidency of Maréchal Joffre.

Besides innumerable honors received from his own countrymen, he was awarded many from other governments. Of all these distinctions none was more dear to him than the Distinguished Service Medal of the United States which members of this Association joined in demanding for him.

Many members of this Association will remember gratefully the tremendous interest he took in their operations in France and the invaluable help he gave them in familiarizing themselves with the best and most important methods. At his delightful home with his family he kept open house for these Americans, many of them weary from work at the front.

Tuffier was an interesting and brilliant personality, of fine presence, a clear, logical and interesting speaker, of broad culture, well read and interested in philosophy and art. He was also a great traveller and made three trips to the United States, where he had a host of devoted friends. He also made a trip around the world on the occasion of his going to take part in the opening of the Pekin Union Medical College. He was elected an Honorary Fellow of the American Surgical Association in 1918.

"From the consideration of this active and fertile life one learns the lesson that life is accomplishment; that the man of action does not really die but his work goes on." (Rouvillois, Commemorative Session, Academy of Medicine.)

CHAS. L. GIBSON.



## CARL A. HAMANN

1868-1930

IN THE early 'nineties the medical profession of Cleveland as well as the Medical School of the Western Reserve University received a vital impulse due to the new blood infused into the medical faculty. This impulse soon created an epoch in medicine whose influence has been felt throughout the

field of medical science.

The principal figures in this drama were Hamann, Hoover, Stewart, Howard and Robb. The intellectual and personal force of these personalities coupled with the endowments provided by generous Clevelanders, notably Samuel Mather, Esq., and H. M. Hanna, Esq., created a medical epoch. Emerging from this forceful group Hamann came to the front as the leader in the important office of Dean. The names of Hamann and Hoover will have a permanent place in the history of clinical medicine in Cleveland, especially at the City Hospital which they converted into a great scientific institution.



CARL A. HAMANN, M.D.

A keen mind, tireless energy and a trust-inspiring personality soon gave Hamann such great professional responsibilities that the load was more than a single individual should carry. Added to his clinical activities was his work as an anatomist and a teacher; and in addition to all the rest were the exacting duties of his position as Dean of the Medical School. These influences brought him early recognition by the American Surgical Association, to Fellowship in which he was elected in 1909.

The American Surgical Association appreciates the high qualities of this master surgeon and great teacher. Modest, retiring and humble though he was, he nevertheless made a lasting impression on thousands of students who

have been his pupils; and upon his colleagues who admired his technical wizardry, keen judgment and surgical temerity.

In his chosen field of applied anatomy he was unexcelled. Rarely is it given to one man to be equally a mas'er in two fields but Doctor Hamann was no less a Surgeon than an Anatomist; no less an Anatomist than a Surgeon. He did not seek friendships; but nevertheless Doctor Hamann gained to an astonishing degree the affection and devotion of his students and co-workers, especially in the hospital of which he was for so many years affectionately termed the "King."

That his papers and discussions and his personality carried weight in this Association is evidenced by his elevation to the office of Vice-president in 1929. The Officers and Fellows will remember him as a great surgeon, and a lovable, kindly personality.

GEO. W. CRILE.

## ERRATA

In the February issue of THE ANNALS OF  
SURGERY the Memoir of

Francis Wisner Murray, M.D.

should have been dated 1855-1929 instead of  
1873-1929.

### EDITORIAL ADDRESS

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## EFFECT OF HIGH PROTEIN DIET ON THE VELOCITY OF GROWTH OF FIBROBLASTS IN THE HEALING WOUND\*

By SAMUEL CLARK HARVEY, M.D. AND EDWARD LEE HOWES, M.D.  
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THE first step in the healing of an uninfected wound in which the tissues are maintained in close approximation is the restoration of their continuity by the proliferation and maturation of connective tissue. In most instances in the more highly organized and parenchymatous organs or tissues there

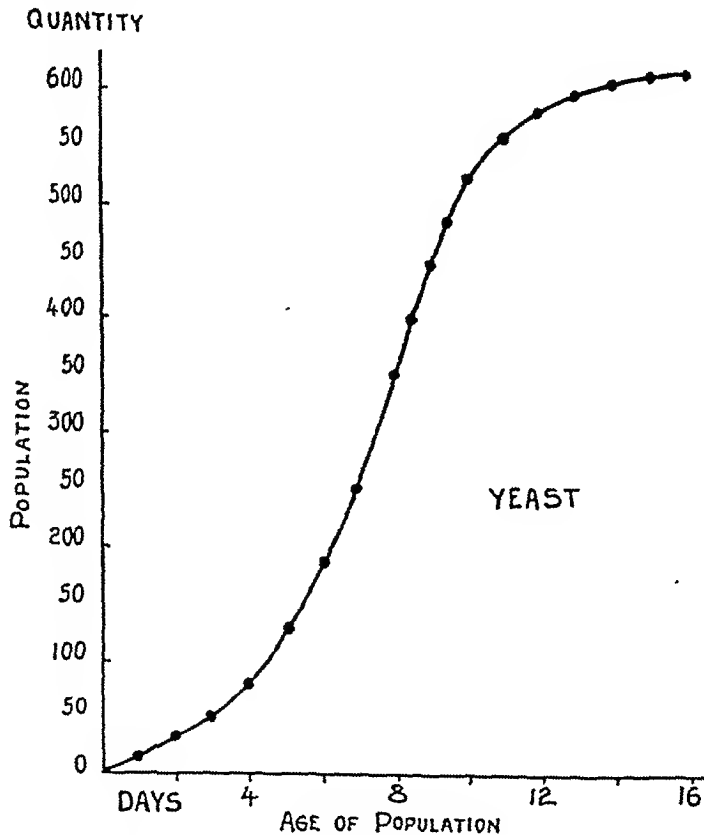


FIG. 1.—Growth curve of yeast population; after Brody and Pearl.

is no restoration of the specific function of these but the end-result is a scar. Where the function is purely mechanical, however, there is necessarily a functional as well as an anatomical result. It is very important to understand as clearly as possible the mechanism by which such a healing is accomplished and the factors which may affect the process.

While the clearing away of the debris of the damaged tissue and the

\* Read before the American Surgical Association, May 3, 1929.

vascularization of the process are essential, the master reaction is that of the multiplication and growth of the fibroblasts which are to form the cicatrix. A function of this is the change in the tensile strength of the healing wound which can scarcely be dependent upon else than the increase in the number of the fibroblasts and the degree of condensation of the connective tissue. When plotted as a velocity curve, this has certain characteristics which are analogous to similar graphs of growth of populations, of metazoa, and of the changes in a monomolecular chemical reaction.<sup>1</sup> (Fig. 1.) This curve of the healing wound was first demonstrated by determining its strength in skin, muscle, fascia and the stomach wall of the dog.<sup>2</sup> (Fig. 2.) Later, with more simple and better controlled observations a similar curve was plotted

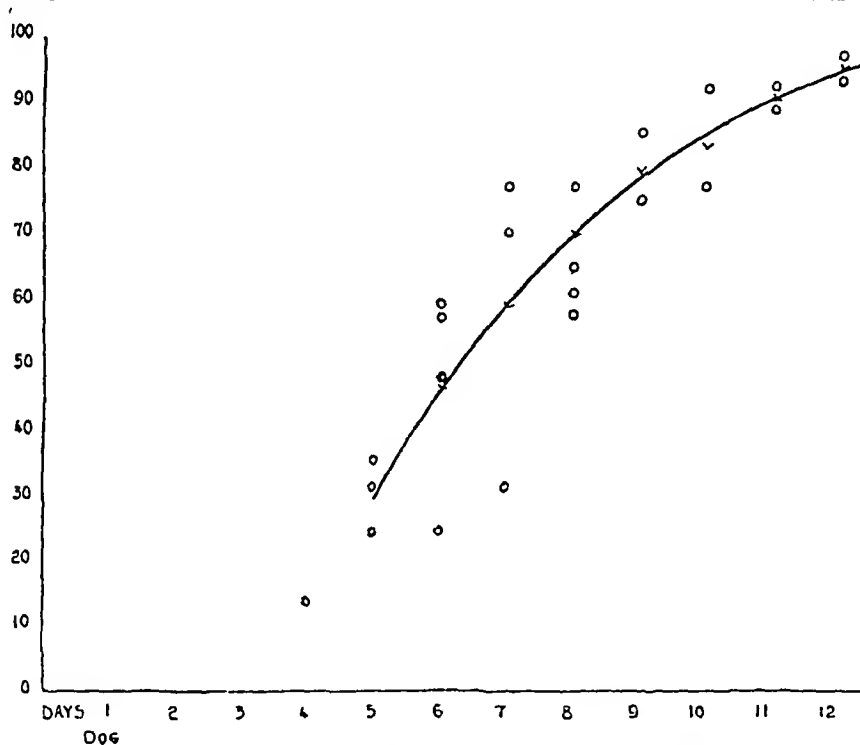


FIG. 2.—Curve of tensile strength in healing wounds of dog.

from experiments upon the stomach of the rat.<sup>1</sup> (Fig. 3.) It is the purpose of this paper to discuss further observations upon the velocity of fibroplasia in the healing wound of the stomach of the rat, particularly in relation to variations in the diet.

The albino rat was chosen as the experimental animal in part because the relatively low cost, as compared with that of the dog, permitted the multiplication of the experiments; in part because this animal has been so thoroughly studied as regards its growth under standardized diets, both adequate and deficient. It is also possible to obtain rats that have been bred from pedigreed stock and fed throughout life on a correct maintenance diet. The size of the tissues rendered it necessary to devise a particular technic for the determination of the strength of the healing wound. The experiments

## PROTEIN DIET IN WOUND HEALING

upon the dog had indicated that wounds in the wall of the stomach healed with uniformity, consequently this organ was chosen in the rat. It being impossible because of the size to determine the tensile strength directly, it was decided to estimate this in terms of the breaking point of the wound when the stomach was distended with air. The animal was killed with ether, the œsophagus tied and the stomach removed, it being kept moist with physiologic

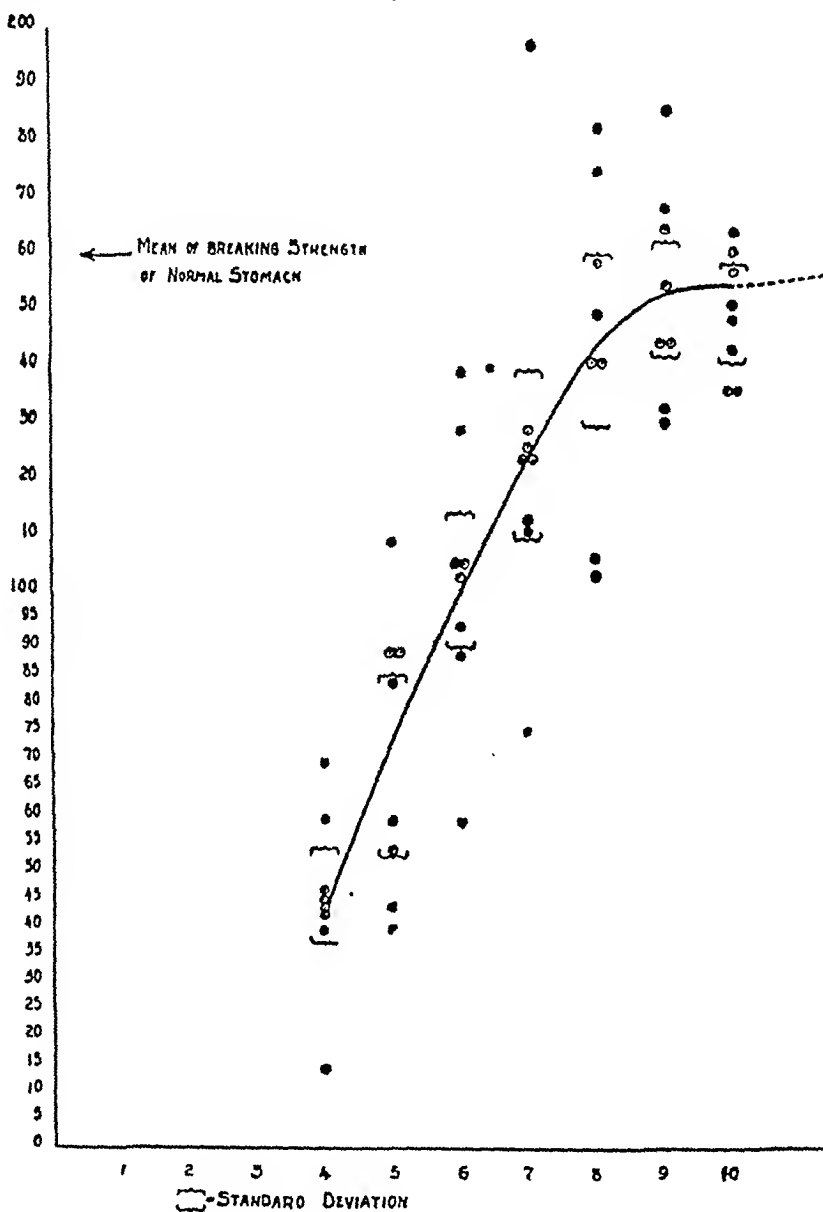


FIG. 3.—Curve of velocity of growth of fibroblasts in healing wound of the stomach of the rat.

saline during all manipulations. A cannula was inserted through the pylorus and this connected to a pressure line to which was attached a mercury manometer carrying a writing point against a revolving drum. Air was admitted at a constant and uniform rate in all experiments, as checked by the rapidity of rise of the mercury. Calibration of the graph against the manometer enabled one to read off the pressure at the time of rupture of the stomach or wound in terms of the height of the column of mercury. (Fig. 4.) It is conceded at once that this gives no absolute value of the strength

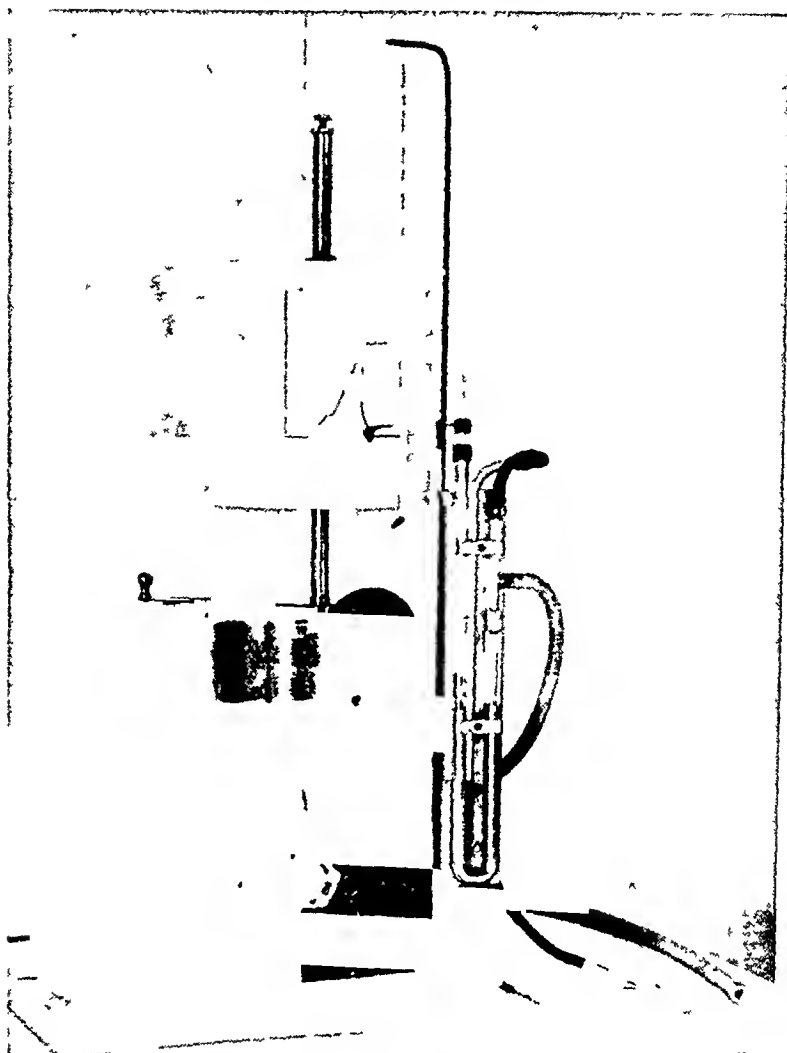


FIG. 4—Apparatus for testing tensile strength of rat's stomach

of the stomach or of the wound but inasmuch as the data desired are that of the relative change in strength, the method seems adequate.

In order to determine possible variations in relation to sex, weight or age, the breaking strengths of many stomachs of rats showing wide variations in these factors were determined. These animals were obtained from various sources and were homogeneous only in that they had not been subjected to operative procedures upon the stomach.

The following data were obtained:

Sex	Observations	Mean hg	Mean deviation
♂ .	29	146	19±
♀ .	24	142	14±
Age (days)			
36-100	21	138	13±
100-200	12	145	28±
200-300	1	154	0±
300-400	9	146	15±
400-541	19	154	17±

## PROTEIN DIET IN WOUND HEALING

Sex	Observations	Mean hg.	Mean deviation
Weight (gms.)			
35-100 . . . . .	20	135	13±
100-200 . . . . .	13	145	23±
200-300 . . . . .	16	146	18±
300-400 . . . . .	3	164	1±
400-485 . . . . .	9	160	18±
All cases, 35-485 gms. . . . .	61	148	17±

An analysis of these data shows no marked trend as regards sex, weight or age. It was decided to use adult rats of the weight between two hundred and four hundred grams and at least ten months old for the initial experiments upon the velocity of the curve of healing. These rats were obtained from two sources; from the Osborn and Mendel strain and from the Albino Supply Company. They had always been on a standard maintenance diet and had had normal growth. Under ether anæsthesia a wound approximately one centimetre in length was made through the wall of the stomach on the anterior surface transversely to the long axis and at the junction of the middle and distal thirds. This was carefully approximated in two layers with No. 000 plain catgut which from previous experiments is known to disappear within three days.<sup>3</sup> The method of suture was always the same. The animals were maintained on a Sherman Diet:

$\frac{2}{3}$ whole wheat	1 per cent. weight of wheat as NaCl
$\frac{1}{3}$ whole milk powder	Lettuce twice a week
1 per cent. weight of wheat as CaCO <sub>4</sub>	70 milligrams of yeast daily.

The velocity curve previously reported<sup>1</sup> was obtained in this fashion. While showing that the major part of the curve corresponded with the "growth retarded" phase, the lag period was not sufficiently explicit, nor were the data sufficient to interpret the findings after the ten-day period.

### EXPERIMENTATION

In order to obtain further information on these sections of the curve and in addition to cover the effects of a high protein diet upon the rate of wound healing the following experiments were performed.

The diets employed by Smith and Moise<sup>4</sup> were used and the rats were placed on these one week before the operative procedure.

DIETS (Smith and Moise)		Apportionment of Total Calories
Percentage Composition	Calories per Kilo of Food	
<i>Standard Balanced Diet</i>		
Per cent.		Per cent.
Casein . . . . . 18	738	Protein . . . . . 13.8
Starch . . . . . 51	2,091	Carbohydrate . . . . . 39.2
Crisco . . . . . 22	2,046	Fat . . . . . 47.0
Cod-liver oil . . . . . 5	465	
Salts (Mendel and Osborn mixture) . . . . . 4	<hr/> 5,340	
Lettuce twice a week		
70 milligrams of yeast daily		



	Per cent.	High Protein Diet		Per cent.
Casein.....	80	3,280	Protein.....	68.7
Crisco.....	12	1,488	Fat.....	31.8
Cod-liver oil.....	4			
Salts.....	4	4,768		
Lettuce twice a week				
70 milligrams of yeast				
daily for Vitamin B.				

The animals and their food intake were weighed every three days. They were fasted for six hours pre-operatively but were put back on food immediately after the operation and many of them started to eat as soon as they had recovered from the anæsthetic. Six animals were sacrificed at daily intervals from one to the fourteenth day and their

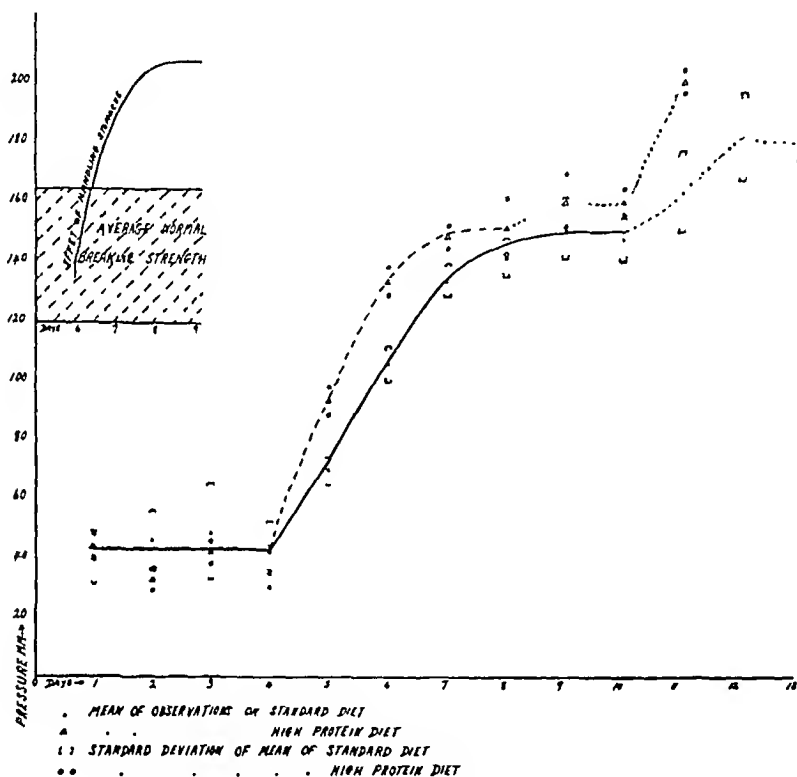


FIG. 5.—Effect of diet on the healing of stomach wounds of rats.

stomachs inflated and the breaking point determined as previously described. If disease elsewhere or infection of the wound was found, the animal was discarded.

*Results.*—The curve for the standard diet was similar to that obtained previously with the Sherman Diet. (Fig. 3.) The high protein diet as contrasted with the standard diet had no effect on the latent period of wound healing, but it did enhance the rate of increase of tensile strength throughout the period from the fifth to the ninth day. (Fig. 5.) (Table I.) The high protein diet also shortened the end point of the curve from the thirteenth to the eleventh day.

(The end point has been arbitrarily set at that period when all the breaks were elsewhere than at the site of the incision. For three or four days before this end point was reached there was a period in which three distinct types of rupture were noted; alongside the incision, directly in the incision, and elsewhere in the stomach than in the incision. [Table I.] As this period approached the arbitrary end point, the number of

# PROTEIN DIET IN WOUND HEALING

TABLE I

P. O. days	Standard diet			Protein diet		
	Mean of tensile strength	Standard deviation of mean	Nature of break	Mean of tensile strength	Standard deviation of mean	Nature of break
1...	41.5	± 9.0		45.4	±4	
2...	47.5	± 9.0		33.6	±4	
3...	49.9	±15		42	±3	
4...	45.8	± 8		38.6	±7	
5...	71	± 5		94	±5.4	
6...	107	± 6		135	±5	
7...	135	± 5.4		150	±5.3	
8...	143	± 6.8		154	±9	2 elsewhere, 1 alongside, 4 incision
9...	153.5	±10		162	±8	1 elsewhere, 2 alongside, 3 incision
10...	150.5	± 7	1 alongside	162	±4	2 elsewhere, 3 alongside, 0 incision
11...	166	±13	2 alongside, 3 incision, 4 elsewhere	202	±4.4	5 elsewhere, 1 alongside, 0 incision
12...	185	±15	4 alongside, 4 elsewhere			
13...	183.9	± 7	None in incision, 7 else- where			
14...	206	±10	All elsewhere			

breaks in the incision decreased while the number of breaks in the stomach itself increased. Both curves are smooth until the beginning of this period, as only one function, the strength of the wound itself, is being tested, but during this period the curve is staggering because two functions, the strength of the wound and the strength of the stomach are being tested.)

It might be presumed that the enhancing effect of the high protein diet was due to an increase of caloric intake on this diet. However, the caloric intake on the protein diet was actually lower than that on the standard diet. (Fig. 6.) On both the animals consumed a smaller number of calories daily on the first two post-operative days than they did on any pre-operative day. This post-operative decrease in caloric intake was reflected in a loss of body weight during this period. They had maintained their weight on both diets pre-operatively. (Table II.)

TABLE II

## Average Maintenance of Body Weight per Day

(Calculated as percentage of body weight at the start of the experiment)

	Start to Operation	Operation to Killing
Standard Diet.....	+ .3 per cent	— .5 per cent
Protein Diet.....	0	— .5 per cent

*Discussion.*—For purposes of discussion the curve may be divided into three portions, the lag period, the period of fibroplasia where the velocity is changing most rapidly and the final phase of the approaching maximum immediate strength.

In all phenomena of growth there is a lag period, which at first thought seems most readily interpreted on the basis that the increment of the measur-

able factor is not sufficiently great to be detected. Such is not the case, however, for with the transplantation of one microorganism into a fresh environment, there is a pause before it begins to divide, as if it were necessary for some stimulating substance produced by itself to reach a certain saturation in order to effect this change. With each succeeding division the interval decreases and the curve sweeps upward in the first phase of an autocatalytic reaction. (Fig. 7.) If, on the other hand, the implantation is large, the lag period is much less, and the curve apparently starts at a higher point, so that the accelerating phase is short and even entirely absent, the greater part or all being in the "growth retarded" phase. This lag period during which the stimu-

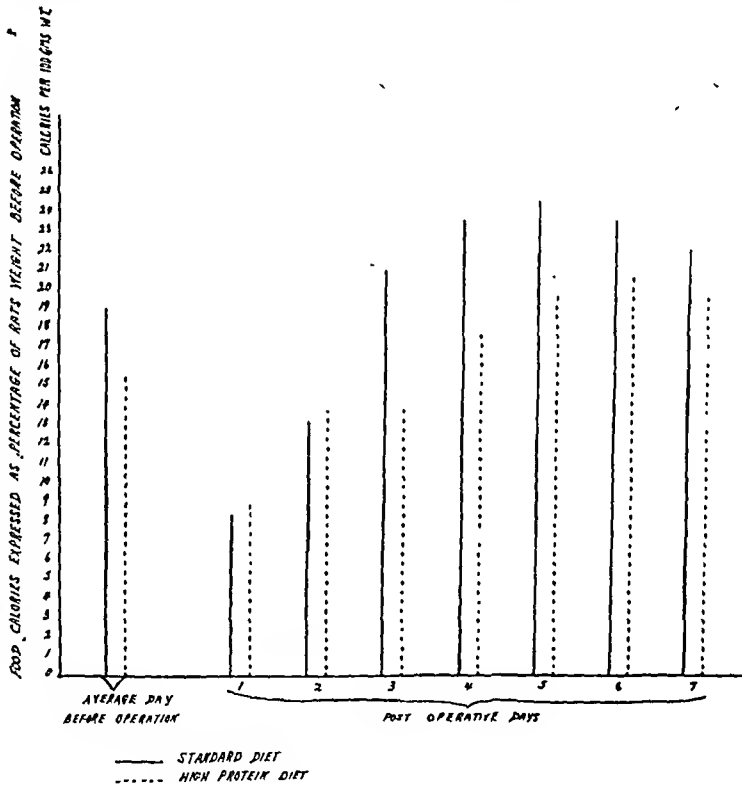


FIG. 6.—Effect of operation on post operative caloric intake of food.

lus to division is accumulating up to a certain point where it is sufficient to set division in action has been previously noted in wound healing. In the data of Durbin<sup>5a</sup> as studied by Thompson<sup>5</sup> upon the regeneration of the amputated tail of the tadpole, the new growth starts after a lag period with little if any phase of acceleration, the greater portion of the reconstruction being in the "growth retarded" portion of the curve. (Fig. 8.) Carrel<sup>6</sup> and his collaborators noted the same phenomenon in the healing of surface wounds, the lag being from three to five days and followed by the abrupt initiation of growth at its greatest velocity. In both instances it is apparent not only that when the stimulus to growth reaches a certain threshold value the many cells in the wound exposed to its action at once start dividing but that the rate immediately becomes retarded so that the healing takes place in the "growth retarded" phase of the growth curve. This occurs likewise in the experiments

upon the rat's stomach. There is perhaps a sufficient density of the population of fibroblasts at the start, so that they at once exert an increasingly retarding effect upon their rapidity of division. At least by the time the tensile strength is beginning to increase at about the fifth day, this is taking place. During the lag period the tensile strength is at the start maintained up to a pressure of twenty-five millimetres of mercury by the sutures which give the immediate strength of the wound, and in the course of a few hours by the deposit of fibrin between the two surfaces. This retains them in contact against a pressure up to forty-five millimetres of mercury until the fifth day when the tensile strength of the fibroplasia surpasses this level.

This lag period was remarkably constant in the experiments in the skin, fascia, muscle and stomach of the dog and also in the stomach of the rat. In the latter both with the normal maintenance and with the high protein diet, this was true. That it may be shortened has been suggested by Clark,<sup>8</sup> who, working with surface wounds according to Carrel's technic, observed a

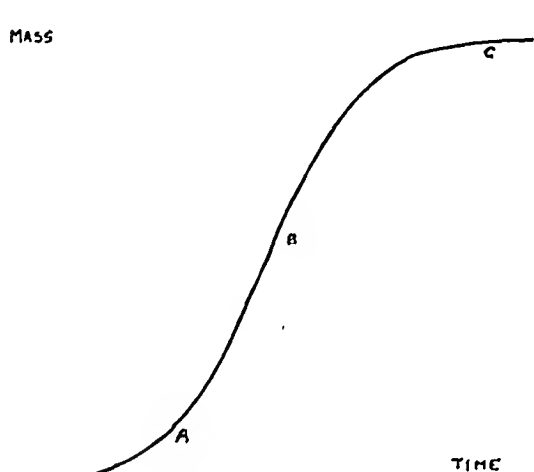


FIG. 7.—Curve of transformation in an autocatalyzed monomolecular reaction; after Robertson.

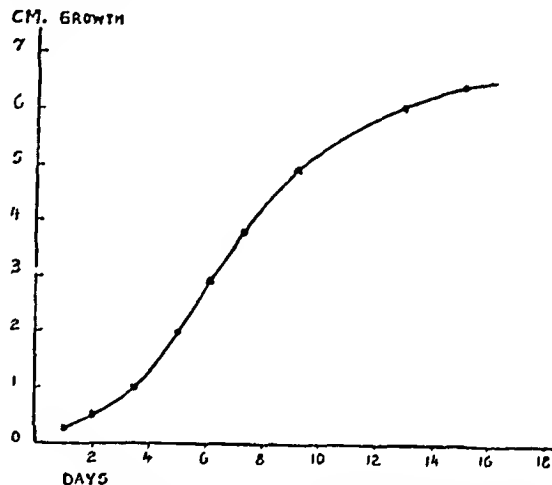


FIG. 8.—Curve of regenerative growth of tail in larger tadpoles; after Thompson.

decrease in the time of the initiation of the growth under a high protein diet. Carrel<sup>7</sup> has himself delayed the initiation of growth by the careful occlusion of the wound from "irritation." He has also initiated regeneration on the first day by applying such an "external irritant" as turpentine. The factor of external irritation is presumably minimal or at least constant in internal wounds.

Whether or not changes in the velocity of the fibroplasia can be brought about is of the greatest interest. Carrel<sup>9</sup> has studied the stimulatory action of embryonic tissue juice upon such cells grown *in vitro* and has determined that this is due to an increased concentration of proteose. Moise and Smith<sup>10</sup> have found that the hypertrophy of the remaining kidney after a unilateral nephrectomy in the rat is greater and more rapid on a high protein diet. Certainly our experiments on the stomach of the rat indicate that under a diet in which the protein content is relatively high, the velocity of growth of the fibroblast in the healing wound is distinctly increased.

In considering the terminal phase of the graph, it is seen that both curves pass into the zone where the stomach customarily breaks. It is evident also

that the stomach in these instances where an operative wound has been made has a greater breaking strength than those not operated upon. (Fig. 5.) One cannot escape the deduction that the manipulation of the stomach has produced some change within its walls which has led to an increase of strength. This can scarcely be otherwise than a reaction to injury which has not been solely confined to the wound area but generalized throughout the entire organ. Whether or not this is due to an increase in the connective tissue is not as yet determined and may not be determinable by the qualitative method of histologic study. Whatever may be the mechanism it enables one to follow the velocity curve through until the wound has attained a strength manifestly greater than that of the stomach before operation. The protein diet, while accelerating the rate of regeneration also brings the wound to a maximum at a period at least two days earlier than that of the rats upon a normal maintenance diet. This maximum remains the same in both instances. In other words the effect of the high protein intake within the limits of this experiment is that of accelerating the rate with which the wound heals but of not affecting its immediate maximal strength or of changing the initial lag period.

#### SUMMARY

1. The latent period preceding the initiation of growth in the healing wound in the stomach of the rat is not affected by a high protein diet.
2. Once growth has started the velocity of it is distinctly increased by a high protein diet.
3. As a result of this the maximum strength of the healing wound is reached some two days earlier than is the case on the standard diet.

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# THE INCIDENCE OF ALLERGY AND ASTHMA IN A GROUP DEVELOPING POST-OPERATIVE ATELECTASIS

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FROM THE WILMER RESEARCH FUND AT THE GERMANTOWN HOSPITAL

IN PREVIOUS reports of our clinical and experimental studies of the post-operative complication of atelectasis we have stressed the finding of three constant etiological factors:

1. The embarrassment of respiratory movements resulting from posture, painful wounds or an abnormal increase in intra-abdominal pressure.
2. The inhibition or loss of the cough reflex, resulting from the pain consequent to the act or following the administration of such sedative drugs as morphia.<sup>14</sup>
3. The presence of a thick, viscid secretion in the bronchi.

We have suggested <sup>1, 2, 3</sup> that the combination of these factors results in the accumulation of thick, viscid bronchial secretions in the dependent portions of the bronchial tree which the patient is unwilling or unable to expel because of painful wounds, muscular weakness and the inhibition or loss of the cough reflex. When this stream of viscid secretion reaches such a bulk as to occlude the lumen of the bronchus at one or more points, atelectasis in varying degrees develops in the pulmonary tissues distal to the point of obstruction.

We have studied this phenomenon by means of the bronchoscope <sup>1, 2, 3, 4</sup> in twenty-four cases, and have been able to relieve the obstruction in all of them by bronchoscopic drainage. We have also reproduced a similar lesion in dogs <sup>5</sup> with the bronchial secretion removed from a patient with post-operative atelectasis. Further <sup>5</sup> we have produced massive atelectasis in dogs when a viscid mass prepared from acacia (Ravdin), having the same physical properties as the obstructing bronchial secretion found in post-operative atelectasis, was introduced into the main bronchus of the animal.

It is not our purpose in this clinical report to review the subject of post-operative atelectasis. From a study of the literature which has been made possible by the complete bibliography compiled by Bowen,<sup>6</sup> the consensus of opinion at the present time seems to agree with Gairdner's <sup>7</sup> original explanation, namely, that atelectasis is the result of the blocking or plugging of the main bronchus supplying the involved pulmonary tissue. Coryllos and his associates have contributed richly to the recent literature <sup>8, 9, 10, 11, 12, 13</sup> and are not only convinced that obstruction is the cause of post-operative atelectasis or so-called post-operative pneumonia, but that lobar pneumonia

is infectious lobar atelectasis, and bronchial pneumonia is infectious patchy atelectasis.

We have suspected for some time that we were observing the terminal stages of the phenomenon, and with others, Cutler, Scott,<sup>15, 16, 17</sup> and Churchill,<sup>18</sup> have not been entirely satisfied with the facts at hand. When our first case of post-operative atelectasis, so successfully treated by bronchoscopic drainage, required subsequent treatment for hay fever, we became interested in the statement of Wilmer, that atelectasis occurs very frequently in asthmatics, and the observation of Clark,<sup>20</sup> based on his review of case reports in literature (Scott<sup>15, 16</sup>-Lee<sup>1, 2, 3, 4, 5</sup>-Bowen<sup>6</sup>), that the incidence of asthma and allergy was very high in patients developing post-operative atelectasis. Finally, when in our last three cases of post-operative atelectasis, we obtained definite histories of allergy or asthma, a review was started in a group of cases that we have been able to follow up.

As a result of this study we wish to report the following:

1. Ten cases of post-operative massive atelectasis have been followed and an analysis of their histories and careful testing has shown all ten of them to be definitely allergic.

2. In all cases the consistency of the sputum has been described as viscid, tenacious and purulent, and apparently similar in its physical properties to the bronchial secretion so characteristic in all allergic individuals manifesting respiratory symptoms.

3. In the positive cutaneous tests we found five reacting to pollen; two to animal emanation; two to bacteria; and one case with eczema probably had a food sensitivity. In listing the results of the tests the major reactor was the only one recorded, but most of the cases reacted to more than one protein.

*Conclusions.*—The surprising incidence of asthma and allergy found in this small group of patients who developed post-operative atelectasis, suggests another etiological factor that should be considered in the study of this phenomenon.

CASE I.—W. G., age forty-two years, Polish, married. Admitted to the Bryn Mawr Hospital October, 1929. Direct inguinal hernia containing a diverticulum of the bladder.

*Operation* December 8, 1929.—Under gas-oxygen-ether anæsthesia a radical repair of the hernia was done by Doctor Lee. Immediately following the operation the man seemed to have more bronchial secretion than usual and with this there was a certain amount of dyspnoea and respiratory distress. He could not or would not cough and at the end of forty-eight hours his temperature had reached 101° F., respirations were 40, and there were signs of consolidation in the right chest posteriorly. Röntgen-ray examination showed massive atelectasis of the middle and lower lobes of the right lung.

*Bronchoscopic examination* and drainage by Dr. Gabriel Tucker. His report is as follows: The mucosa of the larynx and trachea was slightly inflamed. A considerable quantity of thick, yellowish, purulent secretion was found in the tracheo-bronchial tree, coming entirely from the right lung. The right lung was explored and the secretion was found to be coming exclusively from the middle lobe bronchus. A considerable quantity of this secretion was aspirated from the middle lobe bronchus. The left side, after the secretion was aspirated, seemed normal. No secretion reappeared. *Diagnosis.*—

Purulent tracheo-bronchitis with a large quantity of obstructive secretion in the right middle lobe bronchus.

There was immediate subjective relief following the bronchoscopic drainage, but the patient continued to expectorate thick, viscid, bronchial secretion for four or five days. Daily röntgen-ray examinations showed a progressive improvement of the aëration of the right lung and there was complete recovery at the end of seven days.

*Allergic History.*—Pollen sensitivity. For the past six years the patient has been extremely susceptible to attacks of bronchitis, but this susceptibility has existed for as long as he could remember. During the acute attacks there is marked dyspnoea, which frequently requires his assuming the sitting posture, especially at night when in bed. There are also marked symptoms of vasomotor rhinitis during the summer months. Dust increases the symptoms, also the smoke from frying meats and bacon. He has consulted a number of doctors at various times to be cured of his chronic cough and shortness of breath. He has had hives since childhood. While passing along a country road he will at times develop a violent poison ivy eruption.

*Reaction.*—Timothy—3 plus; Red Top—1 plus; June Grass—2 plus; House Dust—4 plus.

CASE II.—C. M., male, white, single, twenty years, Italian. Admitted to Pennsylvania Hospital January 5, 1928, with diagnosis of right, indirect, incomplete inguinal hernia, which had existed for one year.

*Operation* January 7, 1928.—Under gas-oxygen anæsthesia a radical herniorrhaphy was done upon the right side by Doctor Lee. The following day the temperature began to rise, he developed a dry, harrassing cough, and at the end of forty-eight hours the clinical symptoms of massive pulmonary atelectasis of the lower lobe of the left lung had developed. The heart was displaced 3 centimetres to the left of its normal position. There was an ineffectual cough and he raised small amounts of a tenacious, thick, greenish sputum. Röntgen-ray examination demonstrated massive atelectasis of both lobes of the left lung.

January 9, 1928, at 5:45 P.M., approximately forty-eight hours after operation, Doctor Clerf with the aid of a bronchoscope found the left main bronchus completely filled with this secretion. Nine cubic centimetres were aspirated. The mucosa of the trachea and the right bronchus were inflamed. The secretion was not so thick or viscid as is usually found in this condition and was gray in color and filled with many air bubbles. A culture of pneumococci type IV and micrococcus catarrhalis was obtained from the bronchial secretion. Röntgen-ray examination made twelve hours after bronchoscopic drainage showed the heart to have returned to its normal position and the lung to be almost normally inflated.

January 26, 1928.—Röntgen-ray examination showed that all signs of atelectasis had disappeared.

*Allergic History.*—*Diagnosis.*—Bacterial sensitivity, vasomotor rhinitis. He has always been short of breath since childhood, and following exertion he would have to sit down frequently and rest for some time before he could breathe normally. He has considerable trouble breathing through his nose at all times, and when examined it was impossible for him to breathe through his nose.

*Reaction.*—Pollen and animal emanations were negative.

CASE III.—D. D., male, white, twenty-four years, Italian. Admitted to Pennsylvania Hospital October 15, 1927 with left inguinal hernia.

*Operation.*—October 19, 1927, under gas-oxygen-ether anæsthesia a radical herniorrhaphy, left, was performed by Doctor Lee. There was more bronchial secretion than usual immediately after and on the day following operation and the cough was unproductive. Forty-eight hours after operation the patient was evidently having respiratory distress. Lips were cyanotic, there was decreased expansion on the left side of the chest, and a wooden-like impaired note posteriorly over the lower lobe of the left lung. Röntgen-ray examination showed a partial atelectasis of the lower lobe of the left lung.



October 22, 1927.—Bronchoscopic drainage was instituted by Doctor Clerf, which was followed by subjective improvement but not an immediate reinflation of the lung.

October 25, 1927.—The heart had assumed its normal position.

October 29, 1927.—The physical signs in the left lung were normal and röntgen-ray examination showed no evidence of atelectasis.

The patient was again admitted to the hospital September 19, 1929, with a right inguinal hernia.

September 21, 1929.—Under gas-oxygen anæsthesia a radical herniorrhaphy was done on the right side by Doctor Lee. The day following operation harrassing cough developed accompanied by a slight amount of yellow, viscid expectoration.

September 23, 1929.—The respiratory distress had not only persisted but increased, the cough was still unproductive and he complained of severe pain in the left chest. Upon percussion there was a dull note obtained over the entire left lobe posteriorly. The heart was displaced to the left, so that the right border of the heart was at the left lateral margin of the sternum, while the apex was found to be just outside of the mid-clavicular line. The röntgen-ray examination showed massive atelectasis of the lower lobe of the left lung, and fluoroscopic findings were characteristic and unmistakable of atelectasis.

December 12, 1929.—Röntgen-ray examination showed that the atelectasis had entirely disappeared and there was normal aëration.

*Allergic History.—Diagnosis.*—Pollen sensitivity. There was no history of hives, asthma nor hay fever. He has had a cough for about three years preceding the first operation. He describes his cough as a gasping for breath and that he had to sit up in order to obtain relief. There was no expectoration of any kind during these attacks. The cough started in June, 1926, and he was compelled to stop work about Christmas of 1926 because of it.

*Skin Reaction.*—Timothy—3 plus; June Grass—2 plus; Duck Feathers—3 plus.

CASE IV.—S. S., male, white, single, seventeen years, Jewish. Admitted to Pennsylvania Hospital August 18, 1928, with diagnosis of chronic appendicitis.

August 18, 1928.—Under nitrous oxide-ether anæsthesia Doctor Kneidler removed an acutely inflamed appendix and the wound was closed without drainage.

August 21, 1928.—Patient's temperature had risen to 103° F., there was harrassing unproductive cough with rapid respiration. Inspection of the chest showed a marked diminution of expansion on the left side. The heart was distinctly displaced to the left. The right chest was hyperresonant throughout, both anteriorly and posteriorly, while the left chest showed signs of consolidation posteriorly over the lower lobe of the left lung. Röntgen-ray examination confirmed the clinical diagnosis, showing massive atelectasis of the lower lobe of the left lung.

August 21, 1928.—Doctor Clerf removed by means of the bronchoscope thick, yellow, purulent secretion from the trachea and both main bronchi, the greatest amount being obtained from the left main bronchus. Six cubic centimetres in all were aspirated. There were no abnormal secretions in the subdivisions of the right bronchus. In the left bronchus the secretions were sufficient to practically occlude the bronchial orifices. The entire tracheo-bronchial tree mucosa was acutely inflamed. The organism obtained by culture was Friedlander's bacillus.

September 7, 1928.—Final examination with the röntgen-ray showed normal aëration of both lungs.

*Allergic History.*—Vasomotor rhinitis and animal emanation sensitivity. The patient has always had trouble with his nose and there has been marked coryza and he is subject to exacerbations of this condition when exposed to extremes of heat or cold. The mother and sister have had similar troubles with head colds. Patient has had this condition for some years.

*Skin Reaction.*—Sheep's Wool—3 plus; Cat Hair—2 plus; Milk—1 plus.

CASE V.—M. A., female, white, married, fifty-nine years. Admitted to Pennsylvania

## INCIDENCE OF ALLERGY, ASTHMA IN ATELECTASIS

Hospital December 2, 1929 with diagnosis of chronic recurring catarrhal appendicitis.

December 11, 1929.—Under gas-oxygen anæsthesia an adherent and chronically inflamed appendix was removed by Doctor Lee, and the wound was closed without drainage.

December 13, 1929.—The patient had an attack of asthma during the night. She gave a history of having had attacks of asthma during the last five years. The following day the leucocytosis had risen to 21,000, temperature to 101°. Examinations by Doctor Lee and Doctor McMillan agreed in the finding of definite physical signs of atelectasis of the lower lobe of the right lung. There was displacement of the heart to the right, the apex being palpable in the right nipple line, and signs of consolidation were found posteriorly over the lower lobe of the right lung.

December 19, 1929.—Patient's temperature is normal and all signs of atelectasis have disappeared.

*Allergic History.*—Bacterial sensitivity. Following an attack of influenza in 1918 she developed asthma and this has continued since that time. The symptoms will appear after fatigue and especially upon catching cold. At first the attacks came on about every four months, but of late the intervals have shortened. The attacks last three or four days and she is usually confined to bed.

*Skin Test.*—She was found to be sensitive to the pneumococcus protein and has been treated with bacterin therapy with excellent results. Her father had asthma and the patient herself had a definite attack of asthma just before admission to the hospital for this operation.

CASE VI.—E. F., male, white, single, eighteen years. Admitted to the Pennsylvania Hospital August 30, 1927, with diagnosis of acute appendicitis. Within an hour after admission the patient was given gas-oxygen anæsthesia and an acutely inflamed, gangrenous appendix was removed by Doctor Lee from the pelvic cavity. The wound was closed without drainage.

September 4, 1927.—Patient's temperature had reached 101° F. there was a dry, unproductive cough, cyanosis and dyspnoea. On physical examination the heart was found to be displaced to the left, and there were impairment and signs of consolidation over the lower lobe of the left lung posteriorly. Röntgen-ray examination showed massive atelectasis of the lower lobe of the left lung. Heart, trachea and mediastinum were displaced to the left. The upper lobe did not seem to be much involved. The right lung was distinctly emphysematous.

September 10, 1927.—Doctor Clerf by means of a bronchoscope found that the left main bronchus contained a yellow, tenacious secretion which filled the orifices of the upper lobe bronchus and also the lower lobe bronchus. The orifices of the bronchial subdivisions were occluded. Four cubic centimetres in all of the secretion were aspirated.

September 19, 1927.—Röntgen-ray examination shows the heart to be in normal position and there is complete aëration of the lung.

*Allergic History.*—*Diagnosis.*—Bacterial sensitivity. Patient has chronic eczema. He takes cold very readily. There are no nasal symptoms. Upon physical examination a few soft sonorous and musical râles are heard at the base of both lungs. It is difficult to obtain a history from the patient because of his poor mentality. He would not submit to tests; however, the presence of eczema definitely classes him as allergic.

CASE VII.—C. E., male, white, single, fifteen years. Admitted to Pennsylvania Hospital July 26, 1928. Two days before admission he was seized with acute abdominal pain, and upon admission there was a definite mass felt in the right lower quadrant. Under gas-oxygen-ether anæsthesia, he was operated upon by Doctor Lee within an hour after admission, and an abscess containing one-half ounce of colon pus was evacuated and a gangrenous appendix removed. The cavity was drained with two cigarette drains.

July 28, 1928.—Forty-eight hours after operation there was a dry, hacking, unproductive cough, the right chest was definitely fixed and there was displacement of the right border of the heart toward the right. The lower right chest, particularly pos-

teriorly, showed all the physical signs of consolidation. Röntgen-ray examination confirmed the physical signs, showing a typical picture of massive atelectasis of the entire right lung. The diaphragm was high, the heart was displaced toward the affected side, and there was a to and fro motion of the mediastinal contents during respiration. The density was most marked in the right upper lobe.

July 28, 1928.—Doctor Clerf inserted the bronchoscope and found a secretion partially occluding the right middle and lower lobe bronchi. Six cubic centimetres of the secretion were aspirated. The mucosa of the right lower lobe bronchus was intensely inflamed. The left appeared normal. Pneumococcus type IV organisms were obtained from the bronchial secretion removed by Doctor Clerf.

July 28, 1928.—Röntgen-ray examination immediately after bronchoscopic drainage showed practically no change.

August 14, 1928.—Röntgen-ray examination this day showed a complete return of the heart to normal, and the lungs were normal except for a moderate peribronchial thickening on both sides.

*Allergic History.—Diagnosis.*—Pollen sensitivity. Patient has been perfectly well since operation. He has definite symptoms of vasomotor rhinitis, especially of the left nares. There has been marked difficulty in breathing through one side or the other of the nose for a long time. A sister has the same trouble and has definite hay fever. His attacks of rhinitis occur about every four or five months.

*Skin Reaction.*—Ragweed Short—3 plus; Orchard Grass—2 plus; Red Top—1 plus.

CASE VIII.—C. L., male, white, age twelve years. Admitted to Germantown Hospital January 9, 1923, with diagnosis of appendiceal abscess. A short time after admission, under ether anaesthesia, Doctor Davis drained an abscess cavity containing colon pus and removed a gangrenous appendix from the patient's loin. Three days after operation acute pain in the right chest developed, accompanied with a fever of  $101^{\circ}$ , pulse 120 and respirations 32. He had all the signs of consolidation of the right lung and a primary diagnosis of pneumonia was made, but changed by Doctor Lee to one of massive atelectasis of the right lung. This clinical diagnosis was confirmed by Doctor Loughrey's röntgen-ray examination. Three days later Doctor Tucker introduced the bronchoscope and found thick, viscid, tenacious bronchial secretion occluding the right main bronchus, and aspirated some of it. The röntgen-ray examination made immediately after this aspiration showed a marked increase in the aëration of the lung. There was progressive improvement in the subjective and clinical symptoms, and a week after the first bronchoscopic examination and drainage a second one was made, when it was found that the bronchi were entirely free of the secretion which had caused the obstruction in the early stages. Röntgen-ray examination immediately after this bronchoscopic examination confirmed the normal position of the heart and the re-aëration of the lungs.

*Allergic History.—Diagnosis.*—Pollen sensitivity. Child's mother had violent asthma and hay fever, and the patient has a well-defined sensitivity to spring pollen.

*Skin Reaction.*—Timothy—4 plus; Red Top—4 plus; June Grass—4 plus; Sweet Vernal Grass—3 plus; Orchard Grass—3 plus.

CASE IX.—I. R., male, white, single, twenty-nine years. Admitted to Pennsylvania Hospital November 25, 1929 with diagnosis of left inguinal hernia.

November 29, 1929.—Doctor Lee performed a radical herniorrhaphy under nitrous oxide-ether anaesthesia. The following day his temperature had risen to  $102^{\circ}$ , there was a dry, hacking cough and but slight expectoration of small amounts of a thick, tenacious, greenish secretion. The expansion of the right chest seemed much diminished near the apex.

December 4, 1929.—There were definite physical signs of consolidation of the left lung. The heart is displaced to the left and the röntgen-ray examination showed definite evidence of massive atelectasis involving both lobes of the left lung. The cough is

more productive today and large amounts of a thick, greenish, tenacious bronchial secretion are being expectorated.

December 15, 1929.—The chest symptoms have entirely disappeared and the heart has returned to its normal position.

*Allergic History.—Diagnosis.*—Pollen sensitivity. Patient gives a history of being subject to frequent head colds for the past two years. These occur especially in the fall. He is unable to eat eggs and has no desire for milk. The mother has frequent attacks of hives and hay fever.

*Skin Reaction.*—Timothy—3 plus; Red Top—2 plus; Sweet Vernal Grass—2 plus; June Grass—1 plus.

CASE X.—H. P., male, white, single, fifteen years. Admitted to Germantown Hospital February 23, 1926, with diagnosis of suppurative appendicitis. A short time after admission to the hospital he was operated upon by Doctor Lee under ether anaesthesia and a gangrenous appendix lying retrocæcally and retroperitoneally was removed. The abdominal cavity was drained with a small cigarette drain. During the anaesthesia there was an unusual amount of mucus. Following the operation the patient was cyanosed and could not be persuaded to cough.

February 25, 1926.—Twenty-four hours after operation the right side of the chest seemed to be immobile, while over the lower portion and posteriorly there were definite signs of pulmonary consolidation. Röntgen-ray examination by Doctor Loughrey showed massive atelectasis of both lobes of the right lung.

February 26, 1926.—Doctor Tucker introduced a bronchoscope and found complete occlusion of the lower and middle lobes of the right lung by tenacious secretion. About 20 cubic centimetres were aspirated. It was so thick that it could be completely inverted in the test tube without disturbing it. The left bronchus was perfectly normal and contained none of the secretion. The patient was somewhat more comfortable after bronchoscopy, but refused to cough or expectorate the secretion because of the abdominal pain which resulted. Upon being threatened with a second bronchoscopy the cough was somewhat encouraged, so that within two or three days it became more productive.

March 4, 1926.—Röntgen-ray examination showed a marked increase in aëration in the right lung, especially in the lower lobe.

March 20, 1926.—The heart had returned to its normal position and the lung was fully aërated.

*Allergic History.—Diagnosis.*—Animal emanation sensitivity. He has occasional coughs and colds, as stated in pre-operative history, and an uncle is subject to asthma and hay fever. On his paternal side, his grandmother has been a sufferer with asthma for years. One sister has vasomotor rhinitis and rose cold, with marked conjunctival irritation of the eyes. The patient himself experiences shortness of breath very frequently when in school and when he remains quiet for a long period. He gives a definite history of inability to eat fish in any form or of any kind, finding that it makes him violently ill, and he is convinced that beets affect him in the same way.

*Skin Reaction.*—Goose Feathers—1 plus; Duck Feathers—2 plus.

It is interesting to note that one year after the abdominal operation this patient had a mastoid operation and there were no pulmonary complications following this procedure.

In conclusion we wish to say that testing with all the proteins was not on the above-mentioned cases, as our only object was to prove by cutaneous tests that they were allergic to at least one or more irritants.

NOTE.—Since the reading of this paper Doctor Ashhurst has called our attention to the report of Montague Dixon, from the War Memorial Hospital, Melton Mowbray, England, in which he discusses the desensitization by peptone before laparotomy. In his search for an explanation of post-operative pneumonia, he was impressed with the fact that the acute lung conditions one sees in "general medicine" are commonly the result

of asthma, acute pulmonary œdema and massive collapse. "Might not the pneumonia which follows surgical operations be initiated by a lung change brought about by an influence similar to that which occurs in these medical cases? These changes are probably anaphylactic in origin, and the proteins obtained from the intestines."

It occurred to me, therefore, that it would be wise to try the effects of desensitizing patients with peptone before the operation. To this end I gave 0.3 grams of peptone and 2 centimetres of normal saline solution fourteen hours before the anæsthetic was given. Results were so encouraging that we have now adopted this treatment, in all abdominal sections in which there is time for such preparation, as a routine in our practice. No case which has had the peptone has developed pneumonia. There has been no other change in our method.

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# PARTIAL RIB-REMOVAL WITH CLOSED DRAINAGE IN THE TREATMENT OF ACUTE EMPYEMA IN INFANCY AND CHILDHOOD

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IF OUR series of 109 recent cases of empyema is like the general run of cases, this disease is relatively common in childhood. Almost one-half of our patients were children. The twentieth annual report of mortality statistics of the United States Department of Commerce <sup>1</sup> shows the death rate from uncomplicated pleurisy (forms not specified) to be between one-quarter and one-third of that from appendicitis. Empyema occurs relatively more frequently in childhood than appendicitis, and its mortality rate especially in infants makes its satisfactory treatment a formidable surgical problem.

It is true that empyema affects children and adults in a very similar manner, yet certain features of the physiology of the chest in childhood indicate that its rational treatment should differ somewhat at this age period and later ones. In the case of infants and young children the mediastinum is less rigid than in adults and therefore yields more readily to changes in pressure. Some adults, perhaps one-third of all, are able to suffer a sudden extensive open pneumothorax of one side without a collapse sufficient to produce death. Experience with soldiers wounded in the chest during the late war abundantly demonstrated this. In the case of children a large opening on one side will result fatally. Even after the pleura has become somewhat thickened from inflammatory changes, an opening in an infant's chest is much more hazardous than in the case of an adult's chest. The bearing of these facts on the mortality from open operation in childhood is obvious and should make the surgeon avoid early open operations.

Another feature of empyema very early in life is its unusually high mortality. This has not as yet been adequately explained. A child's seeming proneness to various complications may possibly throw some light on this problem. Of our four fatal cases, however, only one had any proven complication.

Another interesting point is the extremely low incidence of chronic empyema arising from acute empyema. Graham <sup>2</sup> states that he saw only two cases in two years in St. Louis, and that Hedblom, at the Mayo Clinic, had seen only eleven chronic cases in children in a total of 150 chronic cases. Out of forty-eight acute cases, we have never yet had a chronic case. This cannot be explained by a different type of organism affecting adults on the one hand and children on the other. In our cases the streptococcus hæmolyticus has occurred quite frequently in both, but twice as frequently in chil-

dren as in adults. It was considered by Dunham, of the Empyema Commission, as a very resistant organism, especially likely to produce chronic empyema; yet the children infected with it among our cases have not become chronically infected in a single instance.

Still another generalization which holds for the empyema of childhood, in contrast to that of adult life, is that the speed of anatomico-pathological processes is more rapid in the former. The empyema cavity will therefore, as a rule, be obliterated more rapidly and drainage should be discontinued sooner.

Keeping in mind these special considerations, we present briefly some facts which stand out as deductions from the study of forty-eight successive cases of empyema in children under sixteen years of age, all treated by the same method. Thirteen were infants, two years old or under. Obviously in a brief review it would be impossible to report these cases in detail. Suffice it to say here that abstracts of all the case records are at hand.

*Etiology.*—Pneumonia is by far the most common predisposing cause. It occurred in eleven of the thirteen cases of two years or under and was associated with measles and acute nephritis respectively in two of these. In the case of the two other infants, no cause could be found. Of the thirty-five cases over two years old, three had no cause assigned, twenty-eight had recently had pneumonia, one gangrene of the lung, one septicemia, one influenza without pneumonia, three whooping cough, and one measles. Three of the latter patients had more than one of these diseases.

We found only one patient who developed empyema as a primary process. This one deserves especial mention. He was five years old and was brought into the hospital with the diagnosis of appendicitis. His mother, who brought him, stated that up until twelve hours previous he had been perfectly well. While playing out-of-doors he had been suddenly seized with a cramping pain in his upper right abdominal quadrant and the family physician had thought of appendicitis. Upon examination on admission to the hospital the right chest showed signs of fluid and sixty cubic centimetres of thin pus were easily obtained by aspiration. Two hundred and fifty cubic centimetres of thicker pus were removed a few days later at operation. His recovery was rapid. In this case, the onset only twelve hours before and the absence of signs of pneumonia indicate that the pleura was the primary focus.

Coming now to the exciting causes, in the cases two years old or less, the staphylococcus aureus was present on culture in four cases. Pneumococcus of various types was found in six. Two cases gave no growth. For ages over two years, sixteen cases showed pneumococcus, seven streptococcus, seven streptococcus hæmolyticus. Staphylococcus aureus, bacillus coli, streptococcus non-hæmolyticus, and streptococcus viridans each occurred in one case. In six cases the cultures were not reported.

The age incidence in empyema of children is all important as a factor in determining the general mortality in any given series. The death rate is so much greater under two years than later. Of our forty-eight cases, thir-

teen, or a little under one-third, were under two years of age, seventeen were from two to five years, ten from five to ten years, and eight from ten to sixteen years.

*Treatment.\**—In deciding upon the value of any method of treatment we feel that it should be tried out exclusively upon a number of cases for several years in different hospitals. The method here described is one of delayed partial rib removal and closed drainage. It has been applied to all of the forty-eight cases without exception. Patients from two different hospitals have been treated. Collectively the results of the series covers several years and are therefore not especially affected by temporary factors like epidemics.

Any discussion of treatment brings up what we regard to be the most important single modern contribution of the war to the treatment of empyema. This is the dictum not to operate immediately simply because fluid or even because pus is found. The feeling against early operation was probably gradually developed during the World War from the consideration of the futility of trying to save the lives of soldiers with influenza empyema by early surgical intervention. We feel that the already widely quoted report of the Empyema Commission<sup>3</sup> of the great reduction in mortality under delayed operation is especially pertinent in a discussion of empyema in children. The commission gives two main reasons against early operation: First, the danger of the collapse of the lung before protective adhesions have formed—a danger especially great in the case of children; second, the great danger of blood-stream infection from the absorption of organisms. Two cases are quoted by the commission in which blood cultures before early operation were sterile and twenty-four hours later positive for hæmolytic streptococcus. In other words, the early opening up of tissues by operation provided a ready means of spreading the infection.

Graham and Bell<sup>4</sup> of this commission, working experimentally on animals and human cadavers, have proven that for all practical purposes the thorax may be considered as one cavity instead of two. Furthermore they demonstrated that ten dogs, given streptococcus pneumonia and empyema experimentally and drained early, died in every case but one sooner than similar control dogs which were not operated upon.

Clinically we apply these findings in the following manner: We never operate on a child early, *i.e.* soon after fluid collects in the chest. If by aspiration fluid is obtained which is slightly cloudy and is found to contain a few pus cells we re-aspirate with a pump and bottle aspirator on alternate days and study the fluid with especial reference to the specific gravity.

In fifteen of the reported cases we have found that this becomes progressively higher as the fluid becomes more filled with cells and the products

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\* Dr. Joseph M. Flint, who introduced the closed method of treatment at the New Haven Hospital, suggested to the author that he make a special study of this method. Grateful acknowledgment is made of Doctor Flint's many helpful suggestions throughout the course of the work at New Haven.



of their degeneration. In these cases the specific gravity rose gradually from 1,017 to 1,029, at which latter point aspiration with a fairly large needle was impracticable on account of the fibrin present and operation was performed. In determining the specific gravity, on account of the high viscosity or thickness of the pus, we have found the Hammerschlag Benzine-chloroform method very accurate and convenient.

From the practical standpoint, we consider it the proper time to operate when with successive aspirations the fluid has become so thick that it may no longer easily be drawn through a needle, and the child meanwhile has built up his resistance to the organism.

The operation employed lends itself readily to local anæsthesia. Novocain one per cent. is used wherever possible. Many children with whom local anæsthesia would be very difficult on account of their nervous temperament may be won over if the surgeon makes it a point to be present at the aspirations or to do them himself. If, in spite of this precaution, difficulty is encountered it is safe to use nitrous oxide and oxygen.

The operation which we have employed in these forty-eight successive cases has been the subperiosteal removal of from three to eight centimetres of rib. The site of operation is as far forward toward the anterior axillary line and as low down as previous aspirations have shown pus to be present. The drainage tube is placed as far forward as possible in order to prevent the patient from lying upon and displacing it or pinching it off.

In studying the mechanics of the chest, we have found a homely apparatus very helpful. We call it an "artificial lung and pleural cavity." We have constructed this from a glass jar, a stopper with two perforations, an old rubber glove, and a piece of tubing. Anyone may easily find these materials if he should care to test out the principles involved. Let the rubber glove A (in Fig. 1, left) represent the lung, which we know is elastic. The bottle represents the thoracic wall. Then tube B will represent the primary bronchus, and C the drainage tube. If now a small amount of fluid (pus) be poured into the bottle as in Fig. 1, it will of course mainly sink to the bottom, only rising slightly along the glove (visceral pleura) by capillary attraction. If now suction be exerted upon the interior of the bottle through the drainage tube C (see Fig. 1, right) the glove will displace the contained liquid and it will be delivered through C to the last drop. The rubber glove representing the lung will be expanded and will fill the space even between the fingers (interlobar fissures). No matter how small a quantity of pus is introduced, it will be delivered through the drainage tube C, even though its opening is far above the general level of the fluid. If a mercury gauge is connected to the outlet system, the negative pressure required to empty the artificial pleural cavity will be equal to the elasticity of the artificial lung plus the equivalent of the length of a column of the fluid from its upper level to the drainage tube.

Binnie<sup>5</sup> says, "I feel strongly that in empyema, the chest should be opened at the angle of the seventh, eighth, or ninth rib and after slow

evacuation of the pus the finger should explore the cavity and find that point which will be low both for the erect and recumbent postures. At this low point free drainage will be established." In backing up this argument for a second or counter opening, he quotes Chevrier,<sup>6</sup> who demonstrated on the cadaver that an opening through the sixth rib in the post-axillary line permitted the retention of 650 cubic centimetres of fluid in the recumbent posture, and 1,250 cubic centimetres in the erect, while figures for an opening at the eighth rib and scapular line were 300 cubic centimetres and 200 cubic centimetres respectively.

Binnie's contentions for a low drainage site are perhaps well taken where open drainage is used. His quotation shows the futility of trusting to a

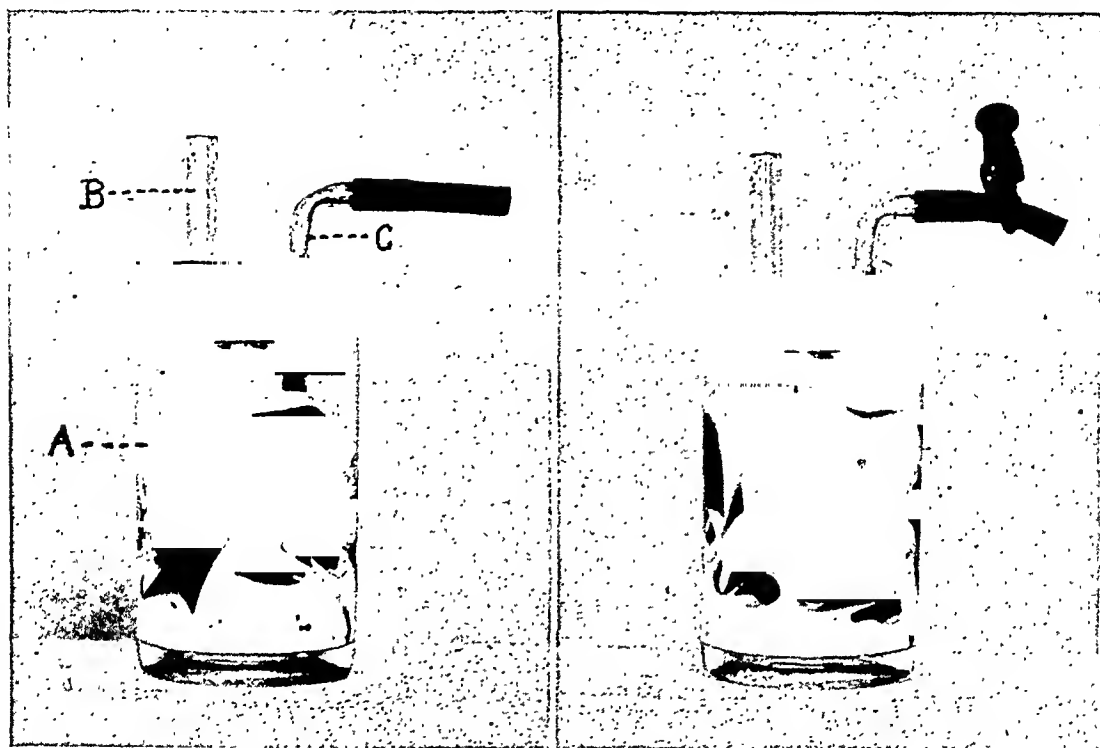


FIG. 1.—Illustrating the value of negative pressure in a closed system for draining empyema. For explanation see text.

method of open drainage to *drain the chest efficiently at any site*. We do not wish to appear dogmatic, but our experimental apparatus indicates to us that with such a method we will either get overflow drainage or we will aspirate air through the sinus in order to replace the fluid draining out. The latter is hazardous because of the almost inevitable secondary infection which occurs.

With respect to the proper drainage site our conclusions therefore are:

1. With suction in a closed system no matter how high the pleural opening is made, the fluid will drain out.
2. Knowledge of these facts should keep surgeons from being over-anxious to drain at the lowest possible site, and should therefore prevent such accidents as perforation through the diaphragm into the abdominal cavity.

Three cases of peritonitis arising from this cause were reported in this country only two years ago.

To continue with the question of operation once the portion of rib has been removed, the periosteum and pleura are divided and the empyema cavity gently and thoroughly explored with the examining finger. Care is taken to rid the pleural surfaces of all fibrin coagula. These often take the form of large chunks or plugs. Sometimes, by placing warm normal salt solution in the cavity, these will float up to the incision and may be removed. Care must be taken not to have the salt too hot and to keep the opening plugged with gauze most of the time. These precautions are both taken to prevent coughing and straining from reflex pleural irritation.



FIG. 2—Rubber drainage tube with dam attached for sealing it hermetically to the chest wall.

The remainder of the operation is simple, consisting of closely suturing the periosteum, subcutaneous tissues and skin in layers about a single fenestrated tube one to two centimetres in diameter extending to the depths of the cavity, and having attached to it a small rubber-dam, shown in Fig. 2, which fits closely to the skin about the tube. A small amount of "K. Y." jelly is placed between the skin and the dam and the latter is strapped down with adhesive.\*

Following operation, the drain tube is connected with a pus trap and this in turn with two ordinary water bottles arranged in the usual way for siphon drainage. The suction should be maintained constantly by keeping

\* Rubber-dams with drainage tubes attached may be obtained in small and medium sizes from The Baumann Rubber Company, 492-494 Congress Avenue, New Haven, Connecticut.

the upper bottle filled with water from the lower as often as it runs out. With tight connections one change of water will last for several hours. One bottle should be about twenty-four inches above the other to give the proper negative pressure. In some hospitals negative pressure is available in all the wards through a suction pump. In these a mercury gauge must be used. The pus trap should have its contents measured and the amount recorded each day. After about seven to nine days, when the amount has markedly decreased, the tube is temporarily removed, shortened, and then re-strapped to the chest. It is then shortened every three days until by X-ray and physical signs no fluid is found to be present. A small tube transfixed by a safety pin is then placed in the opening and healing usually soon occurs. If after the pleura is closed the superficial wound is slow in healing, Dakin's solution is employed to aid in its sterilization.

After operation careful dieting with intermediate feeding and forcing of fluids should be employed in all cases, since many of the children are very emaciated. We encountered a secondary anæmia in several children which is very refractory to treatment. In these cases sodium cacodylate and transfusion of blood have been of great value.

The method of partial rib resection and closed siphon drainage which we employ has the following advantages over open drainage methods: (*a*) it absolutely avoids the danger of open pneumothorax which may be fatal; (*b*) it makes a low opening for dependent drainage unnecessary; (*c*) it does away with the inconvenience of frequent dressings and the danger of secondary pleural contamination from the skin; (*d*) it eliminates the development of chronic empyema from acute cases; and (*e*) it gives an extremely low mortality rate in children of all ages.

We have never found it necessary to irrigate an acute empyema with Dakin's or other solutions. Though other authors do this, we have found it unnecessary and therefore inadvisable. Results have been better without it. In a certain percentage of cases especially in children, the sensitive pleura will be dissolved by the hypochlorite solution and a broncho-pleural fistula will result from its use.

Out of the forty-eight cases treated by this method of suction drainage only four died.

#### ANALYSIS OF FATAL CASES

CASE I.—The patient, aged twenty months, gradually declined and died one month after operation. The cause was not definitely explained, since there was no autopsy.

CASE II.—The patient, an infant of eighteen months, became gradually weaker and died ten days after operation. No autopsy.

CASE III.—A child of three years was unconscious before operation. Death came twenty-four hours later. Autopsy not granted.

CASE IV.—Child, aged six years, had whooping cough, broncho-pneumonia, and stomatitis preceding operation. At autopsy no free pus was found in the pleura, only a patch of fibrin and purulent exudate, about 2 centimetres in diameter at the left apex near the mediastinum. A fibrinous pleurisy was also found in the opposite chest.

The last seven children of the series were treated at Vanderbilt Hospital. Two were under two years and five over this age. All were cured by partial removal of a rib and suction drainage by the closed method. No chronic cases developed from these.

## COMPARATIVE RESULTS

Our purpose throughout this study has been to apply a certain system of treatment to all of the cases for a considerable period of time in two different hospitals in order to determine the effect of its exclusive employment upon mortality and chronicity. Table I shows the encouraging results which we have obtained by this system.

TABLE I  
*Results of Treatment as Related to Age Periods. (Author's Series)*

	Age	No. of Cases Treated	Deaths	Mortality	Chronic Cases (Developing from Acute)
New Haven Hospital 1919-1922 and Vanderbilt Hospital 1925-1928	Under 2 years	13	2	15.4%	0
	Over 2 years	35	2	5.7%	0
	Under and over 2 years	48	4	8.3%	0

While it is certain that such factors as epidemics and the nature of the causative agent and its virulence may, for a time, affect results considerably, yet such factors should logically average up in the length of time covered by ours and by all of the series enumerated in the tables. For example, our results embrace one influenza epidemic. Likewise, culture reports show that our cases have been caused by approximately the same organisms as those reported by other authors.

Statistical studies are often misleading, yet it is evident that the figures quoted in the tables from a number of large reported series covering several years should at least convey a fair impression of results obtained throughout the country. Excluding the unusually high mortality figures from the Babies' Hospital of New York prior to 1913, the average mortality for 276 infants under two years in the various hospitals listed in Table II is found to be 31.4 per cent., while that for 280 children over two years is 15.5 per cent. Our figures of a 15.4 per cent. mortality for infants and of 5.7 per cent. for children are considerably lower than these.

In closing we emphasize one point. Among forty-eight cases there was not a single instance of chronic empyema developing from an acute case. The cured cases were proven cured of empyema by long-time follow-up examinations with re-checks by X-rays. So far as we have been able to find out from the literature, not a single series of this size even in children has been reported without chronic cases, Graham reporting two in his series and Bohrer and Ladd and Cutler reporting several in their series.

# EMPHYEMA IN INFANCY AND CHILDHOOD

## SUMMARY AND CONCLUSIONS

1. Three points render the study of the treatment of acute empyema in children especially important: (a) the high incidence of the disease under sixteen years as compared with that of the combined ages above sixteen; (b) its unusually high mortality rate in infancy; (c) the fact that chronic empyema arising from acute in children should be considered in the light of a preventable disease.

TABLE II  
*Result of Treatment as Related to Age Periods*  
(Series of Other Authors)

Source	Age	No. of Cases Treated	Deaths	Mortality	Chronic Cases (Developing from Acute)
Babies Hospital of New York City Prior to 1913 <sup>7</sup>	Under 2 years	167	109	66.8%	Not reported
	Over 2 years	37	5	13.5%	
Mount Sinai Hospital, New York City 1903-1913 <sup>8</sup>	Under 2 years	111	42	37.8%	"Not infrequently"
	2 to 10 years	89	15	16.7%	
St. Louis Children's Hospital Sept., 1919 to Sept., 1921	Under 2 years	12	2	16.6%	5.8 per cent
	Under and over 2 years	34	4	11.7%	
Bellevue Hospital, New York City 1920-1924 <sup>10</sup>	Under 2 years	48	17	34.8%	2.4 per cent (exclusive of tuberculosis)
	Over 2 years	154	26	16.8%	
Children's Hospital, Boston Prior to 1924 <sup>11</sup>	Under 2 years	48	17	35.4%	11.5 per cent (requiring secondary operations)
	Over and under 2 years	268	52	19.3%	
Johns Hopkins Hospital 1889-1927 <sup>12</sup>	Under 2 years	48	19	39.6%	Not reported
Johns Hopkins Hospital 1927-1929 <sup>13</sup>	Under 2 years	9	2*	22.2%	Not reported
	Under and over 2 years including a few adults	30	4	13.3%	

\* One of these was removed from hospital against advice before death.

2. In the present series the use of irrigations with antiseptic solutions was purposely avoided. The low mortality and complete absence of chronicity obtained without them indicate that they are not necessary in the successful treatment of acute empyema.

3. The system described for the treatment of acute empyema consisting of partial rib removal and sealed siphon drainage is simple enough to be generally used and has yielded results with forty-eight children including thirteen infants, which should commend it to the profession at large.

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# PHRENIC EXAIRESIS IN THE TREATMENT OF PULMONARY TUBERCULOSIS\*

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THE time-honored and established methods of treatment of pulmonary tuberculosis by rest, fresh air and sunshine, and good food have been augmented in recent years by the employment of certain surgical procedures. These surgical methods have not displaced the older regimen but rather are used in conjunction with it. Carson<sup>1</sup> of England advised surgery in the

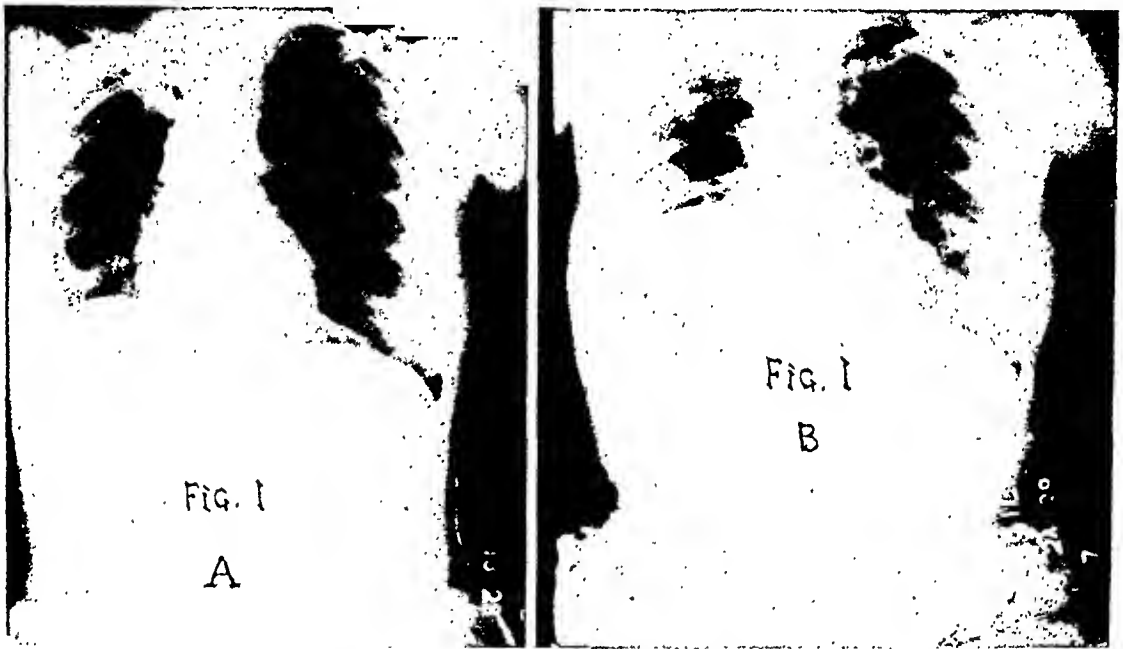


FIG. 1.—J. P., female, aged twenty-six years. Under observation since 1926. Far advanced pulmonary tuberculosis. After three admissions to sanatorium condition became quiescent. Sputa remained positive for tubercle bacilli. She had frequent colds in head and chest following her discharge from the sanatorium. Chest always had many râles and a bronchitis persisted throughout right upper. After operation moistures gradually cleared and lung is now dry for the first time.

treatment of pulmonary tuberculosis as long as one hundred years ago. It was not, however, until 1894 that Forlanini<sup>2</sup> of Pavia first used compression therapy in the form of artificial pneumothorax. J. B. Murphy<sup>3</sup> in 1898, working independently of Forlanini, developed the same idea. This method, however, did not come into routine use in the United States until 1910 or 1912.

There are two methods of compression therapy, the first, pneumothorax, and the second, section of the phrenic nerve combined with thoracoplasty. This procedure reduces the volume of the lung three hundred to one thousand

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\* Read before the Southern Surgical Association, December 10, 1929.



cubic centimetres. Steurtz<sup>4</sup> first suggested phrenicotomy for lower lobe tuberculosis in 1911 and German observers have reported that the lung volume is cut one-fourth to one-third its capacity by phrenic exaeresis.

Unfortunately section of the phrenic nerve or phrenicotomy did not produce results in all cases. This was due to the fact, as was demonstrated by Felix in 1922, that the phrenic nerve often gets branches from the nerve to the subclavius muscle and also possibly from the hypoglossal, spinal accessory, vagus or suprascapular nerve through the ansa-hypoglossi. What is more important is that frequently the phrenic nerve is duplicated in the neck. We have seen a number of cases in which there seem to be nerve fibres coursing in the same direction as the phrenic nerve and yet outside its sheath. This

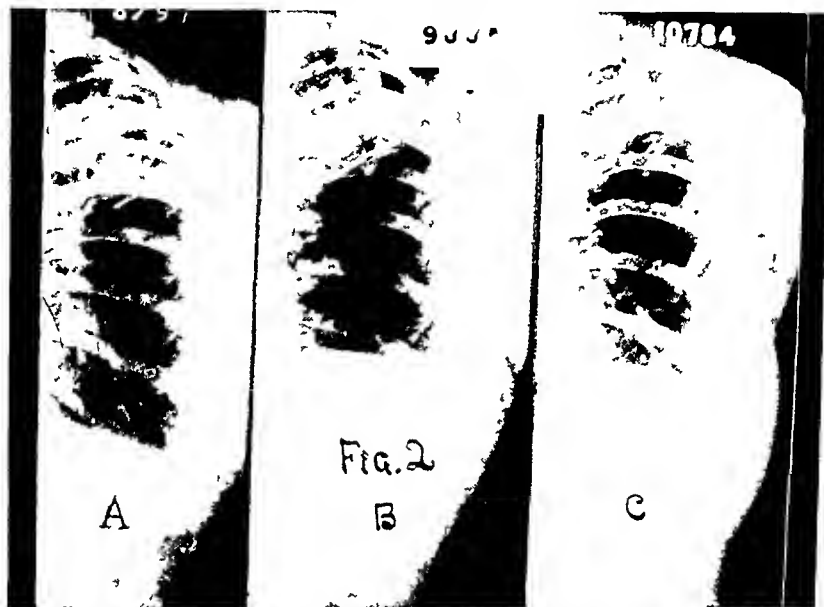


FIG. 2—L. P., female, aged thirty eight years. Pulmonary Tuberculosis far advanced, no pulmonary changes following three months' rest in bed (Fig 2A) Tuberculous laryngitis healed, general condition improved. Phrenicectomy done as a preliminary to pneumothorax. (Fig 2B) One month after operation one cavity had disappeared and two others were reduced 50 per cent. Five months later (Fig 2C), cavities no longer visualized and all sputa negative for tubercle bacilli.

accessory phrenic nerve may lie as far as three centimetres lateral to the true phrenic and goes along with the nerve to the subclavius muscle. This accessory phrenic passes in front of the subclavian vein while the true phrenic goes behind it. Lower in the thorax these two nerves join. According to Felix<sup>5</sup> there is a double phrenic in 20 to 25 per cent. of cases. Goetze<sup>6</sup> found 68 per cent. had accessory nerves and it was Ruheman's<sup>7</sup> observation that 64 per cent. were abnormal.

To overcome this double enervation of the diaphragm two operations were devised: Goetze divided the phrenic nerve low in the neck and also cut the nerve to the subclavius muscle. This procedure is difficult and has fallen into disfavor. The second method, namely of avulsion of the phrenic nerve, was suggested by Thiersch<sup>8</sup> and first done by Willie Felix. This is the

method which is commonly used today and is the one that we have used in all except a very few cases. In these there were large vessels crossing the nerve trunk and as traction was made on the nerve these vessels were pulled into view. Fearing that with further traction the vessels would tear we were satisfied to section and remove two or three centimetres of the nerve trunk.

The advantage of avulsion is that the nerve may be taken out in its entirety or, if not, that enough may be obtained to break the connections with the accessory phrenic and so obtain complete (diaphragmatic) paralysis. Alexander<sup>9</sup> is of the opinion that the union with any accessory branches occurs in the upper twelve centimetres of the phrenic nerve and therefore total paralysis of the diaphragm would be expected when that amount of

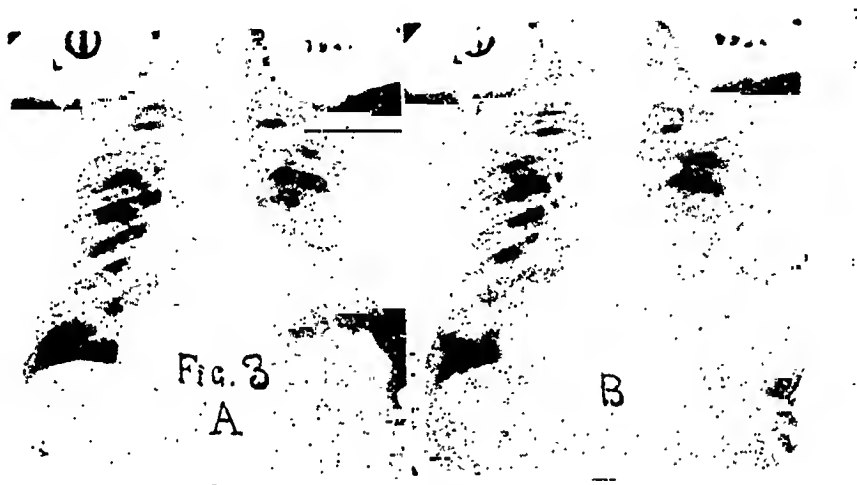


FIG. 3.—J., negro, male, aged fifty-four years. A.—Basal tuberculosis, sputa positive for tubercle bacilli. Phrenicectomy, February, 1929. Fig. 3B, four months later, shows rise of diaphragm, compression of lesion, and absorption taking place. Sputa negative for tubercle bacilli and patient is symptom free.

nerve is obtained. That the location of the union of the accessory and true phrenic nerves is not constant has been shown by Goetze who found one case where the junction occurred three centimetres above the diaphragm.

We first began our work in this field in August, 1926, at which time we did an avulsion on the left phrenic nerve in a young man who had been in a sanatorium more than three years and whose disease was approximately at a standstill. The result in his case was most gratifying and since then we have done this operation on more than a hundred and twenty-five patients. We have carefully studied these individuals and fortunately have been able to follow most of them. It is our purpose to review a hundred of these cases and show what results may be expected from this method of treatment.

Of one hundred patients operated by phrenicus exairesis, thirty-nine were males and sixty-one females. There was no appreciable difference in the two sides as to incidence, forty-five being on the left and fifty on the right—in five, the side was not recorded.

In this series fifty-four were candidates for artificial pneumothorax; in fourteen this had proved unsuccessful, due to adhesions, and in seven the treatment was discontinued; in some because of adhesions, and in others the lung was to be permitted to reëxpand or was permanently atelectatic. In thirty-two a more or less satisfactory pneumothorax had been induced some time prior to the nerve operation. While clinical improvement was the rule, recovery was uncertain, due to uncollapsed cavities, positive sputum, adhesions, and flexible mediastinum. In the pneumothorax cases subjected to phrenicectomy, the amount of collapse was increased in fourteen and uninfluenced in fourteen.

It was interesting to note that ten of the cases of pneumothorax developed fluid in the pleural cavity immediately after the operation. We are not sure

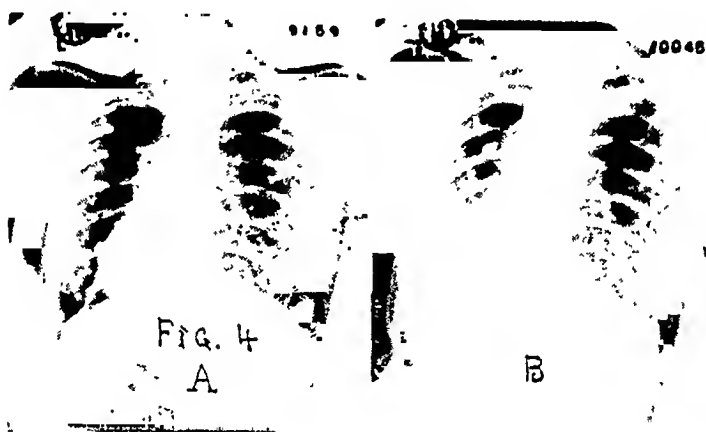


FIG. 4.—J. P., female, aged fourteen years. Admitted September, 1927, age twelve, with far advanced tuberculosis. Had profuse hæmorrhages and all sputa positive. Hæmorrhages recurred from time to time. Pneumothorax induced April, 1928. Last hæmorrhage June, 1928. Cavity uncollapsed, but sputa negative for tubercle bacilli. Following phrenicectomy May, 1929, cavity became obliterated. Fig. 4B—Two months after operation.

whether this is a coincident or not, but we are inclined to believe that it is induced by the avulsion. It occurred in none of the other cases. For this reason we prefer in those selected for pneumothorax, to do a phrenic avulsion first, whenever this is indicated.

Observations on cavities were made in forty-four patients; included in these are those with and without pneumothorax. These disappeared in eight, became less in sixteen, and remained the same in twenty. The elevation of the diaphragm was determined from X-ray films and fluoroscopic examination. It was considered as marked elevation when the ascent equaled two or more interspaces, moderate with an elevation of one interspace, and slight when the rise was less than one interspace. We were able to carry out this observation in all but fifteen patients. The diaphragm showed marked elevation in twenty (at times reaching to the third rib anteriorly); moderate elevation in twenty-nine; slight in fourteen, and no ascent in twenty-two. Fluoroscopic

observations on sixty-eight patients revealed the diaphragm fixed in fifty-eight and mobile in ten. Even where there was no rise of the diaphragm, fixation was the rule. This is a point not sufficiently emphasized and is an important factor in resting the lung and bringing about improvement.

It is interesting to note the effect of phrenicectomy on expectoration; the uniform report was that "it came up easier," and one patient stated that it literally rolled out of his mouth. In some few the sputum was later difficult to raise, particularly when it became scanty.

Reports are available on fifty-six patients, in whom the sputum became less in twenty-two; remained the same in twenty-one, and was increased in thirteen. The increase was temporary in most of these and later became lessened. In eight, with and without pneumothorax, the sputum which had been

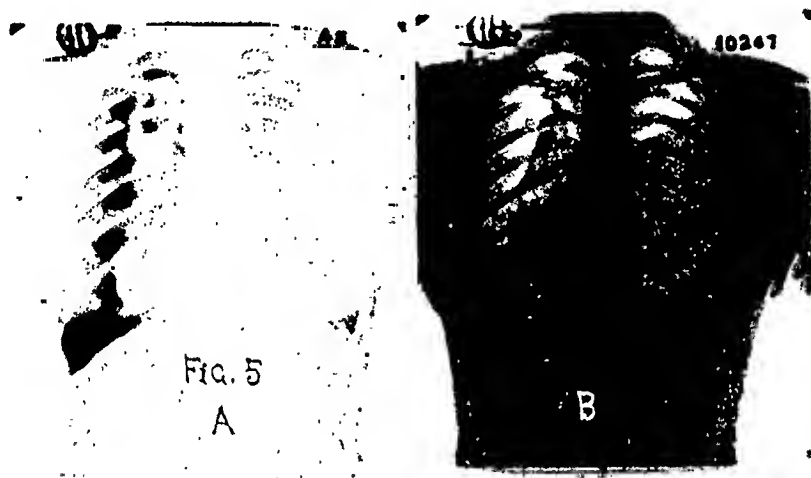


FIG. 5.—M. L., female, aged eighteen years. Artificial pneumothorax begun September, 1928; moderately high pressure (plus 5 to plus 6 half values) failed to collapse large cavity in apex. Following phrenicectomy May, 1929, diaphragm has risen. Fig. 5B, and relieved tension on lung, permitting complete closure of cavity. Three months after operation.

persistently positive for tubercle bacilli became negative. Similar findings obtain for cough, which became less in twenty-two, uninfluenced in twenty-one, and increased in thirteen.

We were particularly interested in dyspnoea and tabulated the findings in sixty-six patients. There was no dyspnoea in thirty-one; slight and transitory in eighteen; moderate and of short duration in eleven; and marked dyspnoea in six. The dyspnoea was aggravated or more noticeable when lying on the back; due to the greater elevation of the diaphragm in this position. In one patient, near the fifth decade, there was slight dyspnoea prior to operation, due partly to a mild emphysema, this was increased by operation and has persisted. The most marked dyspnoea occurred in a woman, which necessitated her sitting up in bed most of the time. The dyspnoea appeared to be due to the marked paradoxical breathing on the paralyzed side. In the course of several months, this has slowly improved. (Figs. 1-5.)

In estimating results one must take into consideration the reasons for phrenic exairesis in each individual case, and the objective sought. If avulsion were induced as a safety factor in an already well-established pneumothorax the condition remained unchanged; many were symptom free and in these no appreciable change would be expected. In the latter group twenty-three patients are included. Of those who remained unimproved or worse there were twenty-four; definite improvement was recorded in forty; and in six sufficient time has not elapsed to warrant any conclusions. Of those who succumbed to their disease, there were seven, but in none of these was their demise traceable to the operation.

The following are indications as applied to our work at Waverly Hill Sanatorium and have been considerations which have led us to operate on the foregoing cases. These do not cover all the indications for phrenicectomy.

We have used it in one case of pulmonary hæmorrhage where artificial pneumothorax failed, without result—the patient continued to bleed and subsequently succumbed.

Where intrapleural pneumolysis is indicated, we would personally prefer to attempt closure of a cavity by phrenicectomy first.

*Indications.*—1. As a preliminary procedure in artificial pneumothorax, especially when cavities are moderately thick-walled, and where the pneumothorax will be carried indefinitely.

2. As a preliminary procedure to artificial pneumothorax when the cavities are thin-walled and situated in the infraclavicular region. Phrenicectomy under these circumstances may result in a complete closure of cavities and pneumothorax be unnecessary.

3. In moderately advanced pulmonary tuberculosis that has shown no improvement following three months' routine bed rest.

4. In patients clinically well who have a unilateral lesion and a persistently positive sputum, in the absence of definite cavitation.

5. In all lower lobe tuberculous lesions, or in those cases where the pathology is predominantly basal.

6. As a preliminary operation to thoracoplasty.

7. In those individuals, who, by reason of temperament, or lack of normal intelligence or self control, are unable to bring themselves to undergo routine sanatorium care, and the prolonged fight and self-denial necessary for recovery, phrenicectomy is helpful.

8. In acute and progressive pulmonary tuberculosis, phrenicectomy may slow the progress and initiate improvement. The negro falls within the latter two indications. Our mortality rate for negroes at Waverly Hill Sanatorium fluctuates between 43 and 61 per cent. Artificial pneumothorax has been unsuccessful in the negro in our hands. With a reasonable selection of patients phrenicectomy offers possibilities for the negro. Cases must be selected in the early stages of the disease if recovery is to be expected. Eight negroes, not included in this series, submitted to phrenicectomy; all were far advanced. Of the six women, three have died, and three are im-

proved; of the two men, both have improved and one has had a continuously negative sputum since operation.

Basal tuberculosis occurs frequently in the negro and in these phrenicectomy, is particularly indicated.

9. As an adjuvant in artificial pneumothorax where cavities remain uncollapsed in the presence of a satisfactory pneumothorax, the relief of tension may bring about closure. This happened in six of our cases.

10. In patients with positive sputa, despite good collapse, and where no cavities are observable in the collapsed lung.

11. In those cases where pneumothorax must be kept up indefinitely, phrenicectomy adds a margin of safety and lessens the number of refills.



FIG. 6.—Exposure of left phrenic nerve through transverse incision. The sheath of the anterior scalene muscle has not been divided.



FIG. 7.—Phrenic nerve exposed through longitudinal incision along posterior border of the sternomastoid muscle.

12. As a final procedure where one is considering discontinuing an artificial pneumothorax and permitting the lung to reexpand, especially if there was preëxisting cavitation.

13. Where pneumothorax is being lost due to adhesions.

14. In artificial pneumothorax complicated by a flexible mediastinum, a successful phrenicectomy tends to increase collapse without resorting to high pressures, thus minimizing the tendency to displacement of the mediastinum.

15. As a supplemental procedure in most cases of artificial pneumothorax.

*Operative Technic* (Figs. 6 and 7).—We have varied our method of approach to the phrenic nerve depending upon the sex of the individual. In

women we make a transverse incision about two and one-half centimetres above the clavicle and about three centimetres long, having its mid-point at the outer edge of the sternocleidomastoid muscle. This muscle is extracted inward, exposing a fat layer in which are a few lymph nodes and several small blood vessels. This layer is separated by careful blunt dissection and the anterior scalene muscle exposed. Care should be exercised not to incise the sheath of this muscle as the nerve may then be displaced with the sheath, so delaying the exposure of the nerve. Furthermore hæmorrhage should be avoided for it obscures colors, making the identification of the nerve more difficult. In some of the men we have used a vertical incision along the posterior border of the sternomastoid. This gives a little better exposure, but on account of the scar we have preferred the transverse incision in women.

In most cases as the anterior scalene muscle is exposed the phrenic nerve will be seen coursing from without downward and inward. At times we have located the nerve on the inner aspect of this muscle, more rarely it is on the



FIG. 8.—A full length of the phrenic nerve obtained from one patient. The cervical end of the nerve is at the 33-centimetre mark. The thickening at the left hand end shows where the branches were given off.

outer surface, and occasionally is located within the muscle itself. When the nerve has been exposed it is injected with 2 per cent. novocaine, sectioned and the distal end gradually twisted out. We have often avulsed thirty to thirty-five centimetres of nerve (Fig. 8) but more frequently the nerve breaks after twelve to fifteen centimetres have been withdrawn.

We believe that in those patients in whom the adhesions about the apex of the lung and mediastinum are very dense the nerve tears more easily and so the full length of the nerve is not obtained.

With the complications of phrenic exaeresis we have fortunately had no experience. They have been listed by Bettman<sup>10</sup> as the following: injury to the thoracic duct, injury to the brachial plexus or cervical sympathetic, and hæmorrhage from the tear of a large vessel. This last complication usually results from the pull of the accessory phrenic. The surgery is not difficult but at times is tedious and should not be attempted by one who is not familiar with the anatomy of the neck and surgery of this region.

*Comment.*—Phrenicectomy is a valuable adjuvant in the treatment of pulmonary tuberculosis in selected cases. From observations in well over one hundred patients, we are forced to the conclusion that the operation will pass through the experience accorded artificial pneumothorax. This first was applied to terminal stage cases, later induced in earlier stages and finally was applied in minimal phases of the disease in selected cases.

In 90 per cent. of our cases the disease was far advanced and in many there was involvement in the contralateral lung of varying extent.

In Bridge and Bly's<sup>11</sup> series recently reported, 85 per cent. were also

third-stage cases. We are in accord with Alexander's<sup>12</sup> opinion that the operation should be performed in early cases that fail to show any response to routine sanatorium treatment.

It is quite possible that the part played by the diaphragm in respiration has been exaggerated. Sewall and Pollard<sup>13</sup> affirm that costal respiration is more effective than diaphragmatic breathing, basing their conclusions on vital capacity observations. The average volume for diaphragmatic breathing was 1341 cubic centimetres and for costal breathing alone, the average volume was 2139 cubic centimetres. Mosso's<sup>14</sup> experiments on himself parallel these, 1350 cubic centimetres for abdominal respiration and 2025 cubic centimetres for thoracic respiration. The subsidiary rôle played by the diaphragm is further evidenced by the bilateral phrenicectomies done on dogs<sup>15</sup> and man<sup>16</sup> without bad effects. The reduction in lung volume has been variously estimated as one-sixth to one-third. Berard and Guilleminet<sup>17</sup> reporting on two hundred and forty cases before the Academy of Medicine, France, estimated a lung reduction of one-fifth to one-fourth. Reduction in lung volume, while essential to the closure of cavities, is not the only factor in bringing about recovery; fixation of the diaphragm with resultant rest for the lung contributes much to the amelioration of symptoms and the clearing of the lung fields. For this reason adhesions in the costo-phrenic sinus are not a contraindication. For in some of our cases not only did fixation occur, but in a few marked elevation as well was observed. This was also noted in Mayer and Leetch's<sup>18</sup> series.

#### CONCLUSIONS

1. Phrenicectomy is a valuable aid in the treatment of pulmonary tuberculosis in selected cases.

2. Of one hundred patients so treated, 90 per cent. of whom were far advanced, 40 per cent. showed improvement; in eight the sputum became negative for tubercle bacilli; and in eight the cavities disappeared.

3. Phrenicectomy is an adjuvant in artificial pneumothorax, and should be considered in every case with cavitation; following avulsion of the phrenic nerve 44 per cent. of our cases showed a better collapse.

4. Phrenicectomy is not a substitute for pneumothorax, but when done as a preliminary procedure, in a small percentage, it will render collapse therapy unnecessary.

5. A good phrenicectomy is better than a poor pneumothorax; it is less hazardous; less discomforting; unattended with complications, and is a necessary preliminary to thoracoplasty.

The good results of phrenicectomy are not dependent on the location of the pathology, but rather on the retractibility of the pulmonary tissue. Basal and mid-lobe lesions offer most, and cavities above the clavicle least, although in the latter with a marked elevation of the diaphragm good results are obtained.



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# TRAUMATIC DIAPHRAGMATIC HERNIA

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EVERY case of left-sided gunshot or stab wound of the chest, or crushing accident of the trunk, may be one of potential diaphragmatic hernia. Given a wound of the diaphragm, the force of aspiration of the thorax is exerted upon the freely movable abdominal viscera. The constant suction action of the thorax due to the negative pressure therein is aided by the entrance of the omentum into the opening which adheres there and prevents union of the edges of the opening, as does also the normal movement of the diaphragm in respiration. Adhesions of the adjacent abdominal viscera, most commonly the stomach and the thoracic viscera, form, and upon contraction of these adhesions the abdominal organs are dragged upward. In small openings this process is a slow one; in large rents from crushing injuries the abdominal viscera *in toto* may enter at once. With long-standing cases the pleura may form exudates which descend into the abdomen and increase the intra-abdominal pressure. A hernial sac rarely forms, the herniating viscera or viscus passing through the hole. The hernia is usually on the left side, as any wound of the right dome of the diaphragm is plugged by the compact and plastic liver, this preventing the movable viscera from entering the right side of the thorax.

The stomach is most commonly the organ which herniates. Giffen claims that a portion of the colon usually accompanies it. The colon is next in frequency to the stomach, while less often the omentum, small intestines, spleen, liver, pancreas, and kidney, are found in the thorax. The stomach usually ascends posterior to the lung, displacing the heart to the right, and crowding the lung toward the mediastinum, until it may become entirely functionless.

There is a wide variation of symptoms, from mild digestive disturbances to marked interference with the heart action. Hæmorrhage and pneumothorax, with collapse of the lung, may occur at the time of the injury, and death result in twenty-four hours. If the patient survives, dyspnœa and gastro-enteric disturbances occur from time to time, without apparent cause. Cyanosis and cough from cardiac displacement and pressure may be present. Anorexia may be persistent. There may be a feeling of fullness after meals and attacks of colicky pain. Pain may be complained of in the upper left quadrant on rising, and a sense of suffocation on lying down. The symptoms often simulate irregularly those of peptic ulcer or cholecystitis with hæmorrhage. Substernal or epigastric pain is probably the most common symptom, and the pain may radiate to the thorax anteriorly, to the back or to the left shoulder. The patient may suddenly develop nausea, vomiting,

constipation, dyspnoea and cyanosis, due to strangulation of the herniated viscera, and death follows unless relief is obtained early. The physical signs are variable and puzzling. The condition has been mistaken in acute cases for pneumonia by competent internists. Naturally the signs vary according to the amount of food, water and air in the stomach and bowel. They may change with change of position. Signs of pneumothorax, hydrothorax, and hydropneumothorax are often noted. The affected side may be prominent and its movements restricted, the subcostal angle may flare and Litten's phenomenon is often absent on that side. There is always a dextrocardia to some degree. The abdomen is often scaphoid.



FIG. 1.—Röntgenogram of chest, showing opacity in left side of chest extending upward from abdomen.



FIG. 2.—Röntgenogram of abdomen after opaque meal, showing barium in small portion of stomach remaining in abdomen.

The literature of diaphragmatic hernia has been much enriched during the past few years by such papers as those of Giffen,<sup>1</sup> Harrington,<sup>2</sup> Stimson,<sup>3</sup> Truesdale.<sup>4</sup> The literature of the condition, however, is not so extensive but that the contribution of single observations is still of value. The report of the following case, therefore, is of interest:

#### CASE REPORT

A white man, aged twenty-five years, entered the Government Hospital for the Insane at Washington, D. C., on March 26, 1924, supposedly in good health although somewhat emaciated. The only events of importance in his history were that while soldiering in the Canal Zone in August, 1920, he had shot himself through the left chest with a 0.48 calibre pistol, apparently with suicidal intent, and that later he was committed to the Walter Reed Hospital for insanity. The diagnosis of the mental condition was catatonic dementia præcox. Because of the psychosis, a history of the illness which constitutes this report was unreliable. On April 17, 1924, the patient began to vomit everything immediately after eating. He complained of being chilly and of having

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abdominal pain. His temperature was only slightly elevated and his pulse and respiration were normal. The vomiting after meals and the pain persisted.

Physical examination revealed considerable emaciation. There were three scars on the thorax. Two of them were about 2 centimetres in diameter; one was 2.5 centimetres below the left nipple in the fifth intercostal space, the other 4 centimetres above the right nipple in the third interspace. The third scar was somewhat larger and located 5 centimetres to the left of the spinous processes in the mid-dorsal region, tenth interspace. The chest was of the elongated flat type. Respiratory excursion was limited on the left side. Tactile and vocal fremitus were not determined because of the patient's inability to coöperate. Percussion of the chest showed no impairment of resonance on the right side. There was an area of flatness extending up to the third rib on the left side, and to a certain extent shifting in character. The percussion sounds over this area changed from time to time and on several occasions the flatness entirely disappeared and was replaced by a distinct resonant note bordering on tympany. Auscultation over this area showed an absence of breath sounds at all times. The cardiac pulsations were visible and palpable in the fourth and fifth interspaces between the right border of the sternum and the right parasternal line. The heart sounds were heard over this area and were normal. The abdomen was markedly scaphoid. Some tenderness was noted in the upper left abdomen and a few hard masses were palpable along the normal course of the colon, particularly the ascending and transverse. The physical examination otherwise was essentially negative.

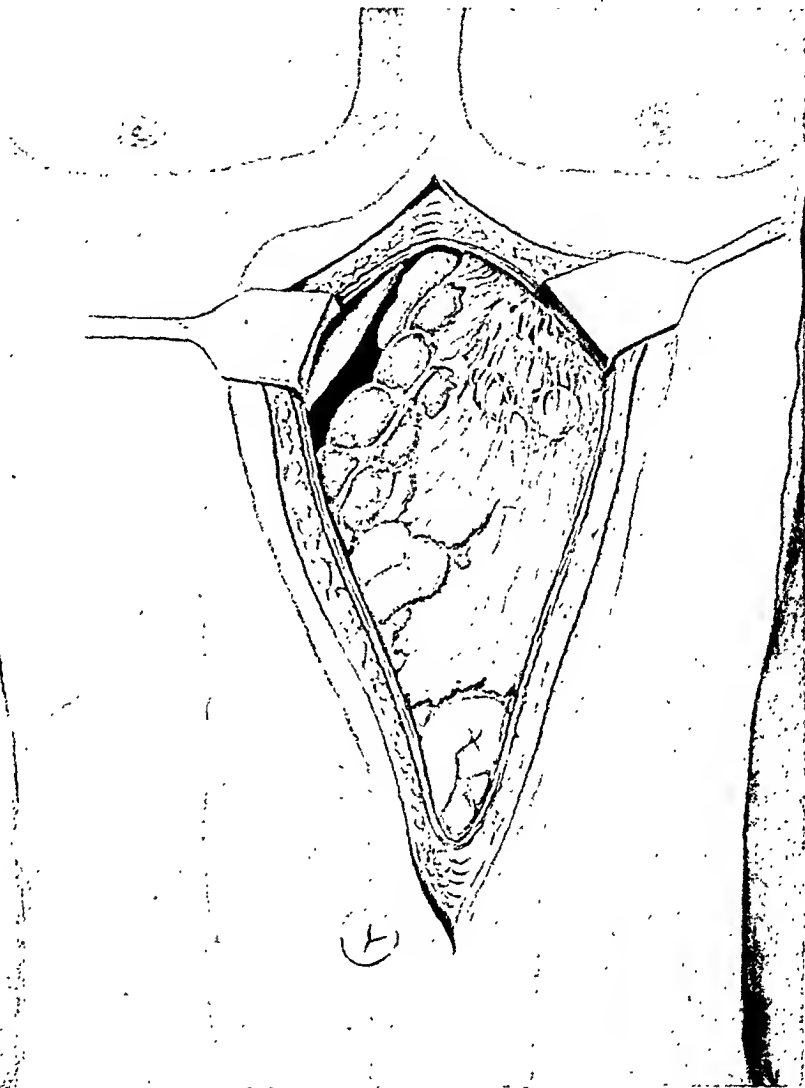


FIG. 3.—Drawing showing appearance of viscera upon opening abdomen.

The laboratory findings were unnoteworthy except for a leucocytosis of about 15,000 on several occasions. The blood Wassermann was negative. Examination of a greenish fluid obtained from paracentesis thoracis on one occasion showed blastomycetes. Examination of the faeces was negative for occult blood. The vomitus showed an absence of free hydrochloric acid, but otherwise was negative.

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A röntgenogram of the chest (Fig. 1) showed a normal diaphragm on the right

side, while on the left side there was an opacity extending upward from the abdomen as high as the third interspace anteriorly, with a smooth, rounded dome above. This area presented practically the same degree of opacity as the liver area. The heart shadow was shown to be displaced to the right. After the opaque meal, which was mostly expelled immediately after ingestion, the picture showed the rounded opacity of a small amount of the meal, to the left of the vertebral column, and just below the

situation of a normal diaphragm. (Fig. 2) Apparently none of the opaque meal entered the herniated greater portion of the stomach, as the roentgenograms of the chest before and after the meal were identical. Incarcerated and obstructed diaphragmatic hernia was considered the most likely diagnosis, and the patient was given a transfusion of 600 cubic centimetres of blood and fluid by hypodermoclysis preparatory to operation.

On April 30, the abdomen was opened under local anaesthesia by a high left rectus incision. The first observation made was that the transverse colon, containing hard lumps of faecal matter, was puckered in a mass under the left dome of the diaphragm, pulling the hepatic and splenic flexure into

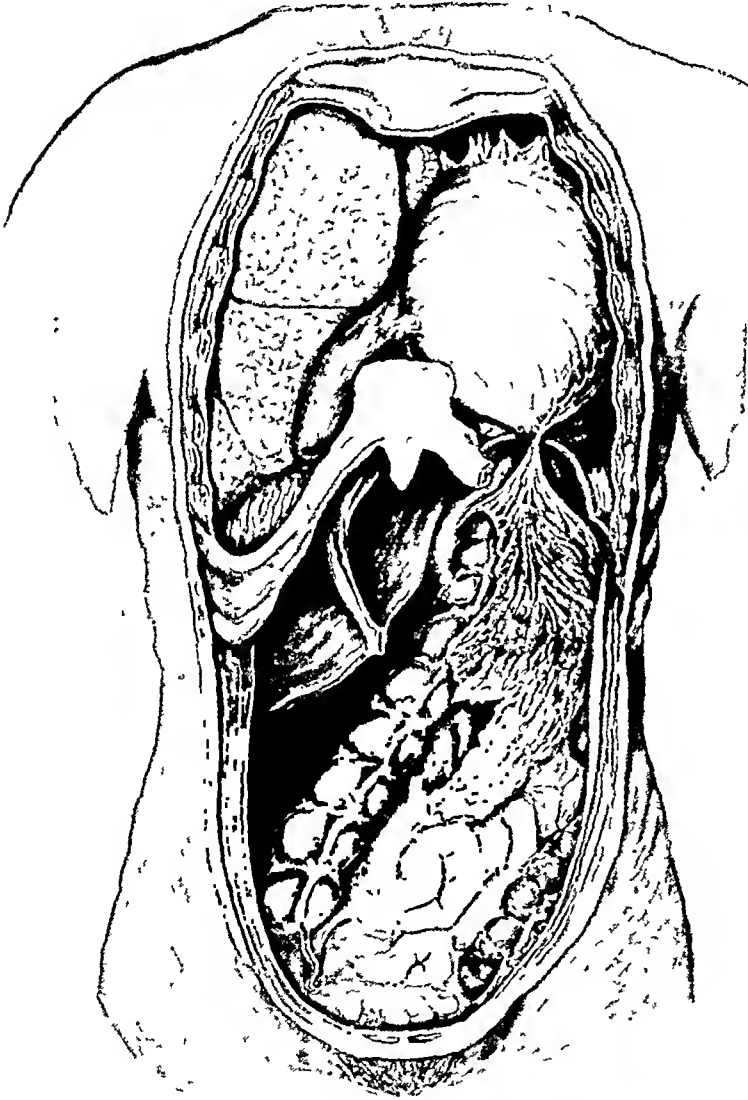


FIG 4—Diagrammatic drawing showing location of viscera in thorax and abdomen

the mass (Fig. 3) The ascending colon had been pulled from its normal position, assuming a new oblique course across the abdomen, from the lower right quadrant to the left dome of the diaphragm. (Fig. 1) Assured that the whole of the small and large bowel was in the abdominal cavity, the operator made a search for the stomach, which revealed its absence from the abdominal cavity, except for a very small portion of the pylorus and the lesser curvature. The oesophageal opening in the diaphragm was normal in size and contour but had been dragged toward the left. The herniated stomach was passing through a small aperture about 4.5 centimetres to the left of the normal position

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of the œsophageal foramen, with the puckered mass of colon and the omentum firmly adherent around the false opening: (Fig. 4.) Adhesions were separated on the inferior surface of the diaphragm and as far as the finger could reach on the superior surface. With all palpable adhesions freed, an unsuccessful attempt was made to return the stomach to the abdomen. The rent in the diaphragm was enlarged by a slight incision and the hand and arm passed into the thoracic cavity. Many adhesions between the stomach and the superior surface of the diaphragm and the parietal pleura and pericardium were found. The stomach apparently filled the left chest. It seemed plausible that after the stomach was

freed from adhesions binding it to adjacent structures that it could be easily returned to its normal position, but this was not the case, even with considerable bimanual push and pull. The question immediately arose as to whether to evacuate the stomach with a trocar and cannula or do a thoracotomy. The former course was chosen and a voluminous amount of gas and fluid were evacuated. (Fig. 5.) The emptied stomach was then pushed into the abdomen with ease and the trocar wound quickly closed in the usual manner. The margins of the rent in the diaphragm were freshened and sutured in the usual

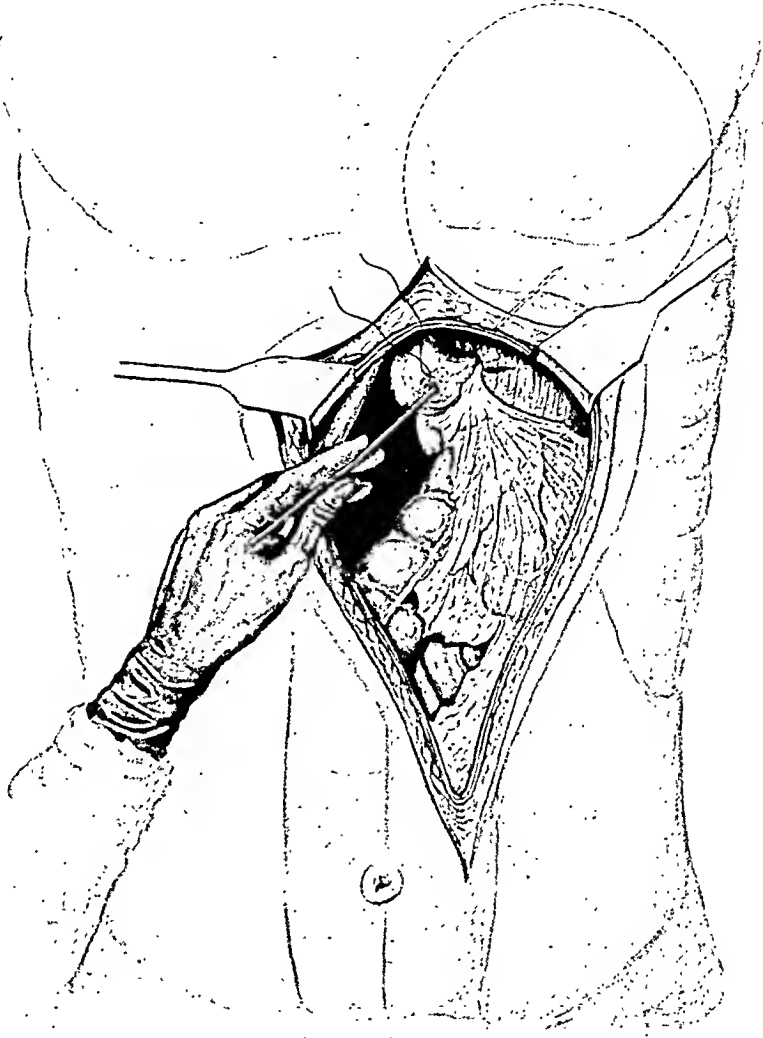


FIG. 5.—Drawing showing insertion of trocar and cannula through pyloric end of stomach to empty thoracic portion of stomach.

way without difficulty. (Fig. 6.) The patient left the operating room in fair condition. Continuous Murphy drip was given, also 600 cubic centimetres of normal saline intravenously, and 500 cubic centimetres of normal saline by hypodermoclysis. The next morning the patient seemed weak, washed out, talked very little, and only occasionally moved his limbs. The pulse was of fair quality but rapid. The temperature was normal. During the afternoon he became suddenly worse and rapidly expired.

Necropsy revealed the left pleural cavity to be almost empty except for about four ounces of blood. The left lung was very small and lying against the spine. The whole upper lobe crepitated on pressure but only the upper portion of the lower lobe. Upon resecting the lung at the hilum about two ounces of creamy pus escaped from the bronchi. The lower four-fifths of the lower lobe of the left lung was solid, with a sharp line of demarcation. The diaphragm on the left showed a rent about 6.5 centi-

metres long which had been sutured and was apparently healing. The right extremity of the rent was about 25 centimetres to the left of and anterior to the oesophageal hiatus of the diaphragm and extending laterally toward the left axillary line. There was a dense fibrous band on the pleural surface of the diaphragm just to the lateral side of the rent extending laterally to the anterior axillary line. The right lung, pleural cavity and diaphragm on the right were apparently normal. The heart was small and in the midline. The abdominal viscera were all present and in their normal positions.

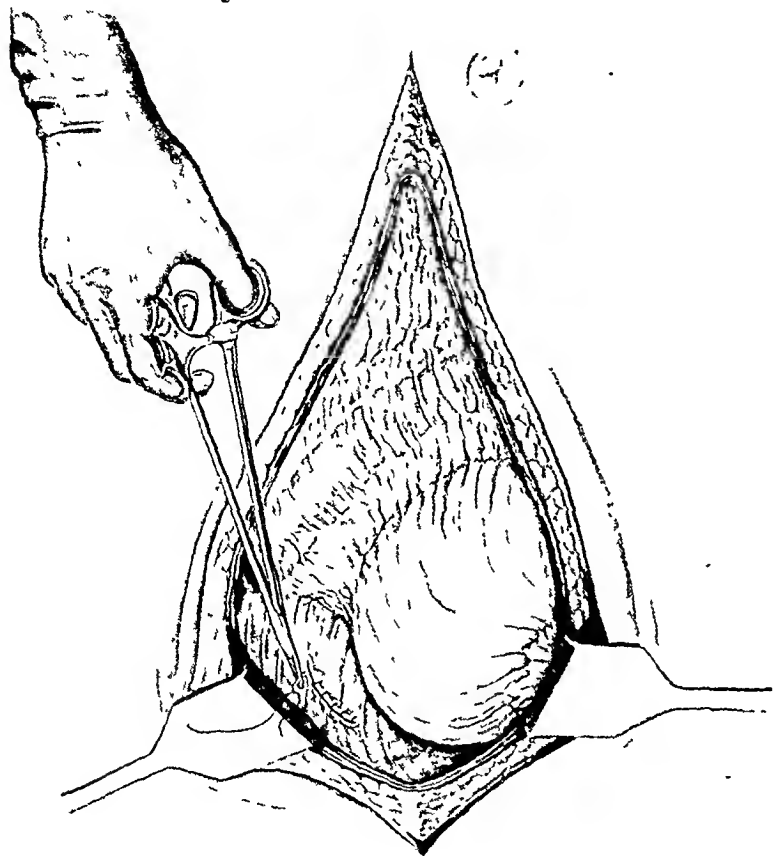


FIG. 6—Drawing showing suturing of rent in diaphragm, with stomach replaced in abdomen.

The incision in the abdominal wall was healing. The repaired trocar wound in the pyloric end of the stomach was located with difficulty and was almost healed. The stomach appeared normal. The small intestines were empty and contained no gas. The cæcum, ascending colon, and transverse colon contained hard masses of faecal matter, but the descending and sigmoid colon were empty. The appendix was long but normal. The liver, spleen, and kidneys appeared normal. The brain was grossly normal.

*Comment.*—The manner of production of the hernia in this case is interesting. There were

three scars on the chest, all resembling those resulting from the penetration of bullets. Evidently the two in the left side of the chest were the scars produced by the entrance and exit of the bullet which had injured the diaphragm. From the location of these two scars the bullet must have grazed the pericardium in the region of the apex and taken out a small piece of the diaphragm. Because of the mental condition of the patient the history of the infliction of the injury and the subsequent symptoms were unobtainable. At the time of his entrance to the Government Hospital for the Insane the emaciation was assumed to be due to refusal to eat. In the light of the condition later revealed

it was probably due to inanition resulting from partial obstruction of the stomach. Four years after the injury the obstruction suddenly became complete, and the subsequent course was rapidly downhill. The operative difficulties were not especially serious, and we feel that recovery would have followed earlier intervention. The inability of the patient to coöperate and the unusual nature of the lesion caused a longer delay than usual in cases of obstruction of the gastro-intestinal tract. The diagnostic puncture of the chest which resulted in aspiration of the contents of the herniated stomach was a dangerous procedure, but fortunately produced no harm. The appearance of greenish fluid containing blastomycetes should in itself have been sufficient to make the diagnosis of diaphragmatic hernia. This is a diagnostic procedure which we, of course, do not recommend.

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# THE COMPOSITION OF THE BILE FOLLOWING THE RELIEF OF BILIARY OBSTRUCTION

REPORT OF A SERIES OF ILLUSTRATIVE CASES\*

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THE wide range of variation in the character of the bile, as observed in the operating room, and in the material obtained by surgical drainage of the biliary tract, is a surgical commonplace. The difference in color and consistency of the bile from the gall-bladder and that obtained from the hepatic duct, the occurrence of thick, tarry "stasis" bile in one case of obstructive jaundice and of "white" bile in another, the different prognostic significance of the finding of white bile at the time of operation, and of its appearance subsequent to the establishment of adequate biliary drainage, and many other similar phenomena have been pointed out as a result of observation in the operating room and at the surgical clinic.<sup>2</sup> Physiologic experimentation, stimulated by the results of surgical experience, has served to explain some of the phenomena mentioned. The work of Rous and McMaster, in particular, has served to emphasize the concentrating function of the gall-bladder, and its rôle in determining the characteristic composition of bile from the gall-bladder and of "stasis" bile, as contrasted with that of the bile secreted by the liver. These same investigators furnished final proof of the relation between the accumulation of the secretion of the mucous membrane which lines the gall-bladder and bile ducts and the appearance of white bile.

In an attempt to elucidate further some of the changes observed in the character of the bile after the establishment of biliary drainage for the relief of biliary obstruction, we made a detailed study of the volume and composition of the bile in a series of surgical cases. Full details regarding the chemical analyses have been reported elsewhere.<sup>1</sup> At this time we wish to present a series of illustrative cases to show the effect of biliary obstruction in man, on the composition of the bile, the normal response to the surgical relief of such obstruction, and the modification of that response as a result of various associated factors.

## REPORT OF CASES

CASE I.—*Chronic cholecystitis with cholelithiasis and choledocholithiasis; cholecystectomy, choledocholithotomy and choledochostomy.* A Greek, aged fifty-six years, had had typical attacks of gall-bladder colic, with transient jaundice, ten and seven years before admission. He had had a third attack six weeks before coming to the

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## BILE AFTER RELIEF OF OBSTRUCTION

clinic. The urine had been dark and the stools light-colored following this last attack of colic, although jaundice never was marked.

When the patient was examined, the sclerotics were slightly icteric. The edge of the liver was felt 2 centimetres below the costal margin and was firm and sharp. There was considerable tenderness in the upper part of the abdomen. The concentration of bilirubin in the serum was 2.5 milligrams in each 100 cubic centimetres and a direct van den Bergh reaction was present. There was moderate retention of bromsulphalein, and cholecystography indicated the presence of a nonfunctioning gall-bladder.

After a period of preparation, the patient was operated on March 3, 1929. The liver apparently was in good condition. The gall-bladder was contracted on many stones, which varied in size from gravel to stones 1 to 1.5 centimetres, and was removed. The common bile duct was dilated to two to three times the normal diameter, and a stone 1 centimetre in diameter was removed from the lower end of the duct. The duodenum was normal. Biliary drainage was established by a Mayo-Robson hepaticus drain inserted in the common bile duct. Post-operative recovery was uneventful (Fig. 1).

Following the operation, there was drainage of moderate amount, 475 to 675 cubic centimetres, of bile of good color. The concentration of bilirubin increased progressively from 31 to 87 milligrams in each 100 cubic centimetres during the first week, and then was reduced slightly. Similarly, the total daily output of bile pigment increased progressively from 200 to 587 milligrams, and then fell to a level of 270 to 280 milligrams. This curve of excretion of bilirubin would suggest that there was some slight washing out of retained bile pigment during the first five or six days of biliary drainage, followed by a fall to the usual output. There was little evidence of retention of bile acids. The biliary material drained on the first day contained a considerable amount of bile acids, which suggests that there may have been some washing out of retained "stasis" bile from the biliary tract. This factor could be excluded by the second day and at that time the bile was characterized by a very low content of bile acids and a greatly diminished total output. From then on there was a rapid

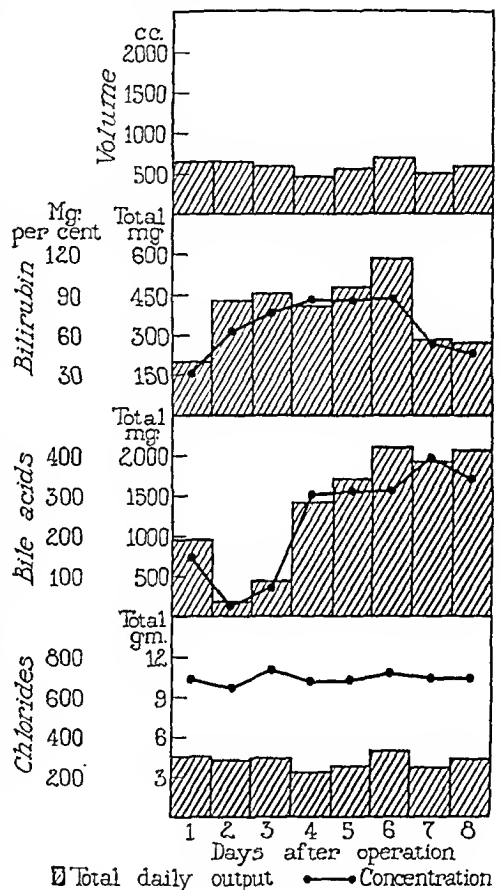


FIG. 1.—Case I.

return toward normal. The concentration of bile acids progressively increased from 26 to 400 milligrams in each 100 cubic centimetres and the total output from 170 to 2,080 milligrams a day. The latter data much more nearly approach those found in investigations on normal dogs. The concentration of urea in the bile was approximately the same as that in the blood, whereas the total output varied from 85 to 236 milligrams, a relatively inconsiderable amount. The concentration of chlorides in the bile varied between 645 and 723 milligrams in each 100 cubic centimetres, a concentration considerably above that present in the blood serum, 553 to 613 milligrams. The total daily excretion of chlorides by this patient varied between 3.2 and 4.8 grams, a relatively inconsiderable amount, although one which might become significant if the biliary drainage were prolonged.

This case is typical of the changes in the composition of the bile as a result of partial biliary obstruction and of the return toward normal following

relief of the obstruction, as observed in a patient in whom the obstruction was neither sufficiently prolonged nor sufficiently complete seriously to affect the recuperative power of the liver. McMaster, Broun, and Rous pointed out that complete or partial obstruction of a biliary fistula in dogs produces a reduction in the volume of the bile, but that there is still greater reduction in the output of pigments, bile salts and cholesterol, so that the fluid elaborated by the liver becomes progressively poorer in the typical biliary constituents. Following the relief of obstruction, they described a copious outflow of bile which persisted until the greater part of the retained biliary constituents had been eliminated. This bile was more dilute than normal, although the increase in volume was such that the output of pigments was increased during the period of choleresis.

There is a marked similarity between the response of this patient and that reported by McMaster, Broun and Rous. The initial increase in the excretion of bilirubin in this case may be interpreted as evidence for the washing out of retained bilirubin, although it is recognized that some of the increase in bilirubin may be explained by hæmorrhage and trauma at the time of operation. The rapid increase in both the concentration and daily output of bile acids in this case speaks for the recuperative power of the liver.

CASE II.—*Chronic cholangitis and hepatitis with obstructive biliary cirrhosis; cholecystostomy.* A man, aged forty-two years, had had repeated attacks of biliary colic two and a half years previously. These had occurred irregularly over a period of six months, at the end of which time he had been operated on elsewhere and the gall-bladder had been removed. In May, 1928, and again in December, 1928, he had had sharp attacks of pain in the epigastrium, followed by jaundice of three to five days' duration. A chill had preceded one attack, and pruritus, dark urine and clay-colored stools had accompanied the jaundice. The last attack had occurred two weeks before admission. The patient was slightly jaundiced. The edge of the liver was firm and extended 5 centimetres below the costal margin. The spleen was just palpable. The concentration of serum bilirubin was 2.2 milligrams in each 100 cubic centimetres and a direct van den Bergh reaction was obtained.

At operation, March 2, 1929, the liver was found to be large and bulky and presented the characteristic appearance of obstructive biliary cirrhosis. The common bile duct was dilated and was found to contain purulent-appearing bile, but no stones. A T-tube was inserted to permit of prolonged drainage. Post-operative recovery was uneventful (Fig. 2).

The volume of the bile in this case was not significantly different (120 to 425 cubic centimetres) from that observed in Case I, and the changes in the concentration and daily output of bilirubin were similar. During the later stages of the investigation the total excretion of pigment was considerably reduced, although the cause of this reduction is not evident. Individual differences between patients, a reduction in the production of bilirubin in consequence of the cholangitis and the obstructive biliary cirrhosis, and the possibility of incomplete collection of bile through the T-tube must all be considered before a final decision is made in the matter. Both the concentration and daily output of bile acids were low at first and increased progressively as

drainage persisted. Recovery was much slower; and the quantity of bile acids excreted fell considerably below the maximal amounts observed in Case I. The changes in the concentration of urea and chlorides were similar to those observed in the preceding case.

The general course of events was the same in this case as in the preceding one. The return toward normal and the whole curve of recovery, especially as far as the output of bile acids was concerned, were slower and less complete. Our experience with dogs with a permanent biliary fistula has indicated that the development of cholangitis, with its associated cirrhotic changes in the liver, may rapidly reduce the attainable concentration of bile acids in the bile. The same would seem to be true in patients and the apparent reduction

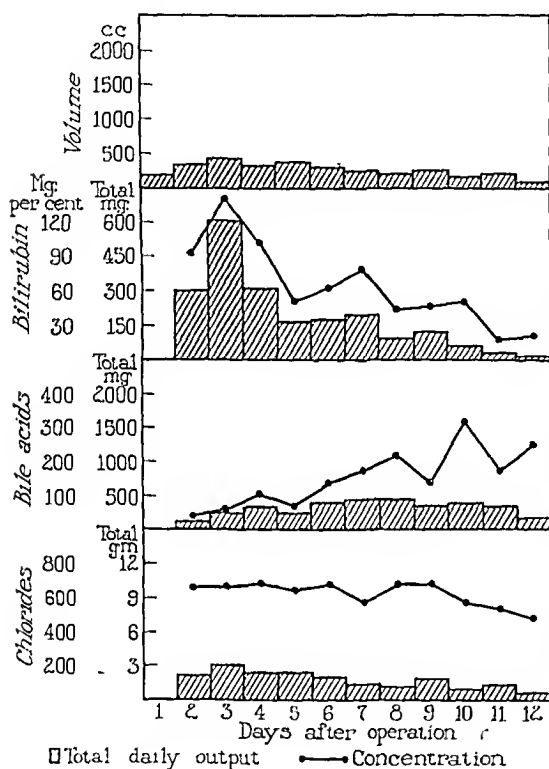


FIG. 2.—Case II.

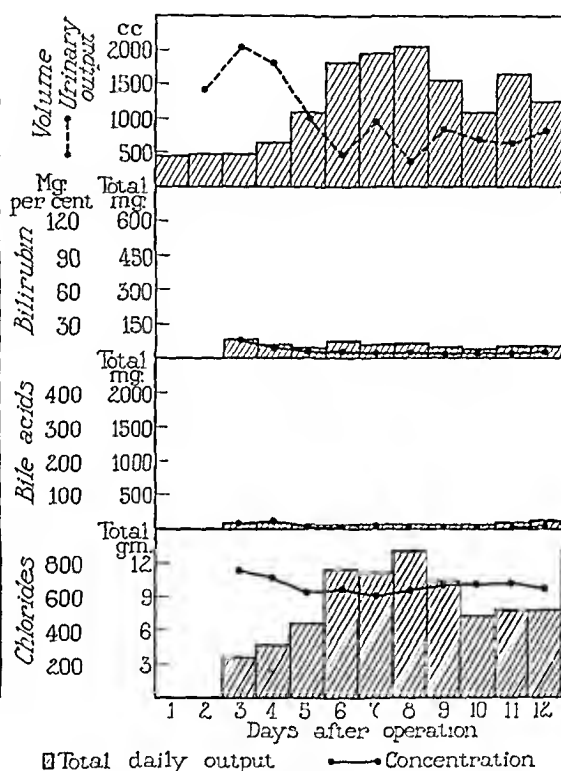


FIG. 3.—Case III.

in the recuperative power of the liver in this case is further evidence of the functional disturbance produced by the combined effects of biliary obstruction and infection.

**CASE III.—Carcinoma of the pancreas with obstructive jaundice; cholecystostomy preliminary to cholecystenterostomy.** A carpenter, aged sixty-six years, had begun to lose weight and strength and had noted failure of appetite in August, 1928. Painless jaundice, with pruritus, dark-colored urine and clay-colored stools, but without associated chills or fever, had developed in November. The jaundice persisted and the patient came to the hospital seven weeks later. At that time he was markedly jaundiced. The liver was enlarged, smooth and firm, and a distended gall-bladder was readily felt. The concentration of serum bilirubin was 24.2 milligrams in each 100 cubic centimetres and a direct van den Bergh reaction was present. Bile was not obtained by duodenal drainage.

After a course of pre-operative preparation cholecystostomy was performed January

Cases III and IV, in order to avoid any serious effects from the cholerrhagia. The latter, however, cannot be ascribed to the forced administration of fluids in these particular cases, for the post-operative treatment was the same in all the cases studied. The cholerrhagia, therefore, must be looked on as evidence of hepatic injury or insufficiency.

## COMMENT

It is recognized that studies such as these are open to criticism from many points of view. The majority of these criticisms are inherent in the nature of the problem to be studied and so cannot wholly be avoided. Particularly is it true that when there is complete external drainage the amount and character of the bile is not the same as when this bile enters the intestine, and the normal enterohepatic circulation is uninterrupted. The cases reported are of interest, however, in that they serve to indicate some of the responses of the liver of man to the effects of biliary obstruction and its removal, as well as some of the modifications of that response in consequence of various associated conditions.

## SUMMARY

The total daily output of bilirubin seems to be more or less constant and not affected by the other factors studied in this series of cases. The concentration on the other hand varied inversely with the volume of the bile. One or two patients showed some evidence of washing out of retained pigment, but if this occurred in all it took place too slowly to show distinctly in observations of as short duration as these.

Biliary obstruction inhibits or stops the formation of bile acids. If the liver is not too greatly injured there is a relatively rapid return to normal; otherwise the return is greatly delayed. This was true both with regard to the concentration and to the total amount of bile acids.

The concentration of urea in the bile apparently varies directly with that in the blood. Ordinarily this pathway of elimination is not significant, but in one case there was considerable loss of urea through the fistula.

The concentration of chlorides in the bile is slightly greater than that in the blood serum. With cholerrhagia the resultant loss of salts becomes so great as to be of clinical significance. The loss of fluids by this channel may also be so great as to cause diminution in the output of urine.

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# THE SEDIMENTATION RATE OF BLOOD AS AN INDEX OF THE HÆMORRHAGIC TENDENCY IN OBSTRUCTIVE JAUNDICE

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THE tendency to bleed post-operatively, in patients with obstructive jaundice, has been recognized and dreaded for a number of years. This fact is of great practical importance because it sometimes leads directly to the patient's death. Walters<sup>1</sup> in 1921 reported that in a series of twenty-nine patients with obstructive jaundice, who died post-operatively, fifteen, or approximately 50 per cent. died as a result of intra-abdominal hæmorrhage. Petren, according to Zimmerman,<sup>2</sup> investigated the operative deaths in gall-bladder cases in the large Scandinavian clinics for twenty years, and found that hæmorrhage had caused 10 to 15 per cent. of all the operative deaths.

All cases of obstructive jaundice do not present this hæmorrhagic tendency, as some patients with a most marked degree of jaundice do not bleed post-operatively, while others with a very low grade, bleed alarmingly following operation. The determination pre-operatively, therefore, of which patients are likely to bleed is important, in order to correct, if possible, the bleeding tendency or at least to prepare for transfusion if necessary.

At the present time there are several tests which are available and used in an attempt to detect this hæmorrhagic diathesis. The coagulation time of the blood *in vitro*, determined pre-operatively, is considered one of the most reliable tests and is the one most generally used. The degree and the duration of the jaundice with the associated dehydration, and the presence of purpuric spots, are considered to be indices of this hæmorrhagic tendency by some surgeons, according to Walters.<sup>1</sup>

There are numerous methods available for determining blood coagulability. Cohen<sup>3</sup> in 1911 reported about thirty, and since then there have been several others added to this list. This multiplicity of methods alone would indicate the difficulty of determining accurately the coagulation time. The most widely used test of blood coagulability is the multiple tube one described by Lee and White<sup>3</sup> in 1915. The normal clotting time by this method is usually considered to be twelve minutes or under. In jaundiced patients one finds quite frequently this increased to twenty or thirty minutes, or even longer. Accordingly, many surgeons believe that a patient with obstructive jaundice who has a coagulation time over ten to fifteen minutes may bleed post-operatively. This is not always the case, however, as it is not unusual to find that such a patient with a long blood coagulation time does not bleed post-operatively, while one with a short or normal coagulation time does bleed. In addition to this, the end point for the coagulation of the blood

is difficult to read accurately, and a great many minutes' variation of this is not uncommonly found in the various tubes of the above method.

Bleeding times seldom show any great variation from normal, so they are of little value. Then also one cannot predict that a patient with a high degree of jaundice will bleed and one with a low grade of obstructive jaundice will not, as the opposite is frequently the case. The same holds true for the duration of the jaundice.

The observation of purpuric spots may indicate a bleeding tendency, but the absence of them does not mean the patient will not bleed post-operatively. On the whole these tests have proven unreliable, as it is impossible to predict with the aid of any or all of them whether or not a patient with obstructive jaundice will bleed post-operatively.

The purpose of this paper is to show that the sedimentation rate of the blood is a more reliable test for the detection of this hæmorrhagic tendency than the others now available. The rapid sedimentation rate of the red cells in obstructive jaundice was first noted while determining the coagulation time of the blood in cats with obstructive jaundice, produced by ligation and division of the common bile duct.\* The rate became more rapid as the degree and duration of the jaundice increased. Because of the unreliability of available tests already noted above, it was decided to run a series of sedimentation rates on patients with obstructive jaundice simultaneous with a series of coagulation times, and to follow them while in the hospital both pre-operatively and post-operatively. My attention was first focused on several cases which bled post-operatively, and these all showed extraordinarily rapid sedimentation rates at the time they bled, despite the fact they were running no fever.

There is not a great deal in the literature concerning the sedimentation rate in obstructive jaundice. Fahraeus<sup>4</sup> to whom is due the recent interest in this property of the blood, reported a rapid sedimentation rate in a great many diseases, but did not include cases of obstructive jaundice. He stated, however, that Schemensky<sup>6</sup> in 1920 reported that the sinking speed of the red cells was increased in icterus. Rosenthal and Blowstein<sup>7</sup> in 1929, reported the sedimentation rate, according to Linzenmeier method, in a group of patients with various types of jaundice. They concluded that the majority of cases with jaundice showed an increased sedimentation rate and in most cases of carcinoma and cholelithiasis, with or without obstruction of the common bile duct, it was rapid. They did not consider the sedimentation time of the blood a specific diagnostic, or prognostic procedure in diseases accompanied with jaundice. Lohr<sup>8</sup> in 1927, also reported he found rapid sedimentation rates in cholelithiasis, with or without jaundice.

A number of procedures for determining the sedimentation rate have been described, but in general these may be divided into two main methods. In one described by Fahraeus<sup>4</sup> the sinking speed is measured by observing, after a definite period of time, the height of the clear plasma above the upper

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\* This work is to be published later.



layer of red cells, and in the other, described by Linzenmeier, it is measured by observing the time it requires the upper layer of red cells to reach a definite mark on the tube. The former is the method of choice, as it is more practical to measure the distance the red cells have settled after a definite time interval, than it is to watch for the upper layer of cells to reach a certain mark. Tubes of different calibre and length are advocated by different investigators and a number of different anti-coagulants are also recommended.

The sedimentation rates, as I have determined them, were done according to a modification of Fahraeus' method, published by Plass and Rourke,<sup>5</sup> except that I have used powdered sodium oxalate as the anti-coagulant, instead of heparin, which they recommend. Sodium oxalate was used as it is cheaper and more readily available, and practically as accurate. Sufficient sodium oxalate to prevent the coagulation of about seven cubic centimetres of blood was used. This was approximately fourteen milligrams, which was not enough to affect the sedimentation rate for practical purposes. The usual procedure was to withdraw about five cubic centimetres of blood, and to mix this with the sodium oxalate. The sedimentation rates were then read from these specimens, usually within an hour's time after the blood had been taken. It was thoroughly shaken before being pipetted into the tubes. Dry apparatus was used throughout, except the syringe, which was washed out with normal saline. This last step prevented hæmolysis of the red cells.

There are several advantages to this method. In the first place the tubes, which are 100 millimetres in length, provide a sufficiently high column of blood to allow an accurate estimation of the sinking velocity of the red cells at fifteen-minute intervals, over a period of an hour. Then also the hæmatocrit readings may be determined in the same tubes, following the reading of the sedimentation rates.

Readings were taken every fifteen minutes for an hour, but only the readings at the end of half an hour are represented on the accompanying charts, as these seemed to indicate more accurately the true sinking velocity of the red cells. In some cases the sinking velocity was so rapid that if the readings were taken at the end of an hour, they would not have indicated even an approximation of the true sedimentation rate. For instance, in the last two readings obtained, in Case I, the rate at the end of half an hour, and one hour, were practically identical. I have arbitrarily called a sedimentation rate below 30 millimetres in half an hour a "slow" rate, and one above this figure a "rapid" one.

Normal values with this method are considerably slower than 30 millimetres in half an hour. The rate at the end of an hour in twenty-two healthy young men varied from 2 to 11 millimetres, and in forty-five healthy young women from 5 to 32 millimetres, according to Plass and Rourke. For practical purposes, these figures hold true for the modification of their method, which I have used.

Inflammatory processes have been shown definitely to increase the sedi-

# BLOOD SEDIMENTATION AN INDEX OF HÆMORRHAGE

mentation rate. The rate has usually been found to be between 30 and 40 millimetres in half an hour, in most of the cases of pelvic inflammation and tuberculosis we have studied. In extreme cases of sepsis with secondary anæmia the rate has increased to 60 millimetres in half an hour.

Other factors undoubtedly enter into the production of fast rates, as all the cases I have reported with rapid rates were practically afebrile, except Case 4, Charts I and III, and Case 9, Chart II. All the cases in Chart III show extremely rapid rates, the average being 50 millimetres in half an hour.

The method used in the majority of the cases for the determination of the coagulation of the blood was the multiple tube one, described by Lee and White.<sup>3</sup> The blood was taken from a vein in the arm with a clean dry syringe and needle. One cubic centimetre of blood was transferred from the syringe quickly, to each of three or four small test tubes 1 by 7 centimetres. The coagulation was followed successively in each tube by tilting them separately. The clotting time was estimated from the moment of puncture, until the least agitated tube, which was usually the last one, contained a firm clot.

Post-operative hæmorrhage in patients with obstructive jaundice may occur immediately following operation—primary or early hæmorrhage—or it may first appear a week or ten days post-operatively—secondary or delayed hæmorrhage. In the former the bleeding usually occurs from the wound edges or the liver bed. It may not be very obvious at the time of operation, but the following day when the dressing is examined, a persistent ooze may

TABLE I  
*Cases with Post-Operative Bleeding*

Case	Diagnosis	Age, sex	Duration jaundice	Degree* jaundice	Coag. time minutes	Bleed. time minutes	Sed. rates	Type of bleeding
1	Ca. of liver with obst. jaundice	60F	6 wks.	25.0	2	1½	48	Early
2	Cholelithiasis with stone in c. bile duct	49F	5 wks.	25.0	7	3	50	Early
3	Biliary sinus with stone in c. bile duct	39F	—	Ict. Ind. 17	6	—	6	Early
4	Ca. of pancreas with obst. jaundice	†66M	10 wks.	21	9	3	50	Early
5	Ca. of pancreas with obst. jaundice	75M	3-4 wks.	19.0	10	—	16	Delayed
6	Cholelithiasis with stone in c. bile duct	49F	2 wks.	16.0	10	2½	14	Delayed

\* Degree of jaundice indicated in milligrams of bilirubin per 100 cubic centimeters of serum.

† Case 4 had a temperature of 99-101° F.

be apparent. In the case of secondary hæmorrhage, there may be no evidence of any bleeding until the removal of some form of drain is commenced.

*Coagulation and Bleeding Times.*—Pre-operative coagulation times are done routinely on all jaundice patients operated upon at this hospital. Analysis of these figures show that they are of little value in the prognosis of post-operative bleeding in obstructive jaundice. Table I gives the pre-operative coagulation times of six cases seen in the past year which bled following operation. It will be noted that in all cases the clotting values were ten minutes or below. The first four of these patients all bled immediately following operation. The last two had secondary hæmorrhage. The bleeding times of four of these patients are also included in Table I. These, like the coagulation times, are within normal limits.

A large number of cases of obstructive jaundice which are operated upon do not bleed. In Table II there are ten cases, all of which presented a very high-grade obstructive jaundice. None of these bled immediately following operation and only one had secondary hæmorrhage. The coagulation time of these ten cases varied from four to twenty-six minutes. Comparison of these values with those in Table I would indicate that the prognosis in regard to hæmorrhage in at least four of the cases, which did not bleed, was worse than in those that bled. The bleeding times recorded in Table II are essentially the same as those in Table I. In addition to this unreliability of the coagulation and bleeding times, as methods of predicting which cases will bleed post-operatively, I found that even at the time post-operative hæmorrhage was taking place there was not always much change in these same tests. Table III shows the coagulation times of some of these cases when actual bleeding was occurring. The five cases in which coagulation times were done show little change from normal; the longest was twenty minutes. In cases four, five and six the hæmorrhage was secondary, occurring seven to twelve days post-operative. In the other four it was primary.

*Sedimentation Rates.*—The sedimentation rate, on the other hand, has proven to be of much more value in predicting hæmorrhage in these cases. Referring again to Table I, three of the four cases which had primary bleeding showed extremely rapid rates. The third one of these, which bled immediately, had a slow sedimentation rate, 6 millimetres in half an hour, but unfortunately the determination was done thirteen days before operation. The day following operation, however, it had increased to 48 millimetres in half an hour. I think undoubtedly if another determination had been done just before the operation, the rate would have been found to have increased, as it is very unlikely that the sedimentation rate would have changed from 6 millimetres to 48 millimetres in twenty-four hours, especially in the absence of fever. The findings in this case are shown in Chart II. Cases 5 and 6 had slow rates but neither bled until about a week post-operatively. At the time bleeding was taking place both had rapid rates. Chart I shows this in detail for Case 5.

The most striking results were obtained in the cases which did not bleed.

# BLOOD SEDIMENTATION AN INDEX OF HÆMORRHAGE

In Table II none of the ten patients bled immediately post-operatively, and only one developed secondary hæmorrhage. The sedimentation rate was slow in all these except Case 9. This patient was running a fever from 100-101° F., due apparently to chronic pancreatitis. Turning now to the results obtained at the time of bleeding, shown in Table III, it will be seen

TABLE II  
*Cases with No Post-Operative Bleeding*

Case	Diagnosis	Age, sex	Duration jaundice	Degree jaundice	Coag. time minutes	Bleed. time minutes	Pre-op. Sed. rates	Bleeding
1	Ca. pancreas with obst. jaundice	44M	6 wks.	12.0	8	3	29	0
2	Cholelithiasis with stone in c. bile duct	42M	1 wk.	+++	5	2½	20	0
3	Cholelithiasis with stone in c. bile duct	48F	8 wks.	6	4	2	22	0
4	Ca. of pancreas with obst. jaundice	60F	1 wk. +	19	14-25	—	3	0
5	Ca. of pancreas with obst. jaundice	47M	3 wks.	25	16-26	1½	1.5	0
6*	Ca. of pancreas with obst. jaundice	75M	3-4 wks.	19.0	10	—	16	0
7	Ca. of pancreas with obst. jaundice	46M	12 mos.	16	19	—	22	0
8	Cholelithiasis with obst. jaundice	50F	1 wk.	12	3	1½	0.5	0
9†	Chronic pancreatitis with obst. jaundice	41M	2½ wks.	18.75	16	—	56	0
10	Ca. of pancreas with obst. jaundice	53M	4 wks.	14.25	9	3	6	0

\* Case 6 had delayed post-operative bleeding but at the same time a rapid rate.

† Case 9 had a temperature of 100-101° F. at this time. About 10 days post-operative a small hæmatoma was drained in the wound.

that all of these cases had very rapid rates, 40 millimetres or above in half an hour. Cases 1, 2, 3, and 4 had primary hæmorrhage, and Cases 5, 6, and 7 had secondary hæmorrhages. These patients were all practically afebrile, except Case 4.

Excluding Case 3, Table I, none of the patients with slow sedimentation rates bled immediately post-operatively, and only two had secondary hæmorrhage. Three of the four cases with rapid rates pre-operatively did

bleed immediately following operation and the fourth one did not. It is worthy of note also, that three of the four which had primary hæmorrhage received a blood transfusion immediately before operation and one of these, also, a very extensive course of  $\text{CaCl}_2$  therapy, indicating that the hæmorrhage would have been more marked if these precautions had not been taken. Only one of the cases with a slow rate was transfused pre-operatively and despite this none in this group had any primary hæmorrhage. The latter case had

TABLE III  
*Cases at the Time of Bleeding*

Case	Diagnosis	Age, sex	Duration jaundice	Degree jaundice	Coag. time minutes	Bleed. time minutes	Sed. rates	Type of bleeding
1	Cholelithiasis with stone in c. bile duct	49F	5 wks.	25.0	9	2½	40	Early
2	Ca. of liver with obst. jaundice	60F	5 wks.	25.0	—	—	56	Early, not marked
3	Biliary sinus with stone in c. bile duct	39F	—	Ict. Ind. 8	6	—	48	Early
4	Ca. of pancreas with obst. jaundice	66M	10 wks.	21	9	3	50	Early
5	Ca. of pancreas with obst. jaundice	75M	3-4 wks.	27.0	14	—	34 and 62	Delayed
6	Cholelithiasis with stone in c. bile duct	49F	2 wks.	13.0	—	—	60	Delayed
7	Cholelithiasis with stone in c. bile duct	27F	2 wks.	Ict. Ind. 40	20	—	50	Delayed

a rapid rate prior to the transfusion, but following it the sedimentation rate was very slow. This patient showed no evidence of bleeding and the sedimentation rate remained slow.

*Case Reports.*—The following four cases with charts are illustrative of the series of seventeen cases of obstructive jaundice studied in the past year. I have chosen two cases which had post-operative hæmorrhage and two which did not.

CASE I.—Chart I shows the findings in a man of seventy-five years who had carcinoma of the common bile duct with obstructive jaundice. On entry to this hospital he said he had noticed jaundice for one day only. That he had been jaundiced longer, there can have been little question, as his serum bilirubin on admission was 19.0 milligrams per 100 cubic centimetres of serum. He was placed on a high carbohydrate low fat diet and before operation he received two 15-cubic centimetre intravenous injections

of 5 per cent.  $\text{CaCl}_2$  solution. A cholecyst-gastrostomy was performed, under spinal anaesthesia, on the sixteenth day after admission. The sedimentation rate and coagulation time done at the time of admission and the day of operation showed no change, despite an increase in the degree of jaundice. There was no abnormal bleeding at the operation. The sedimentation rate had increased on the third day post-operatively. Bleeding from the wound commenced the seventh day post-operatively. It became so alarming, transfusion was done the following day. This practically checked the bleeding. The coagulation time at the time of bleeding remained about the same as before operation. The sedimentation rate was decreased following the transfusion, which corresponded to the checking of the hæmorrhage. The effect of the transfusion was only transitory as the bleeding increased again, and coincidental with this there was a tremendous rise in the sedimentation rate. The coagulation time was also found to have increased by this time. Before death the patient was bleeding from his nose and gastro-intestinal tract, and the sedimentation rate had risen to the extremely high point of 72 millimetres in half an hour.

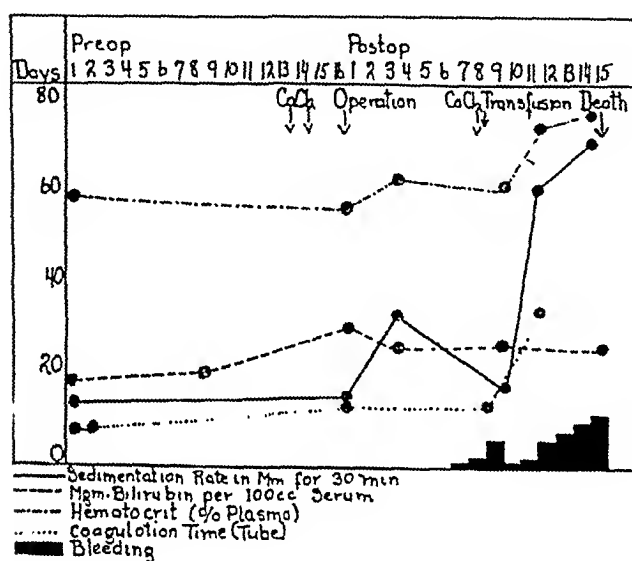


CHART I

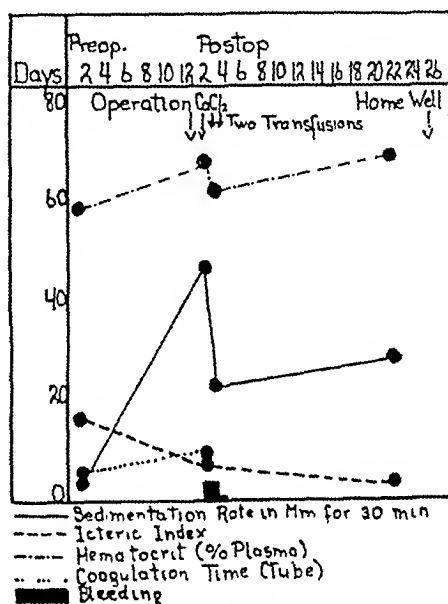


CHART II

*Comment.*—In this case the slow rate pre-operatively indicated that there would probably be no immediate hæmorrhage, and there was none. Post-operatively the increase in the sedimentation rate was directly proportional to the amount of bleeding. The coagulation times did not indicate this until the bleeding was very pronounced on the eleventh day post-operatively. Such an increase in the sedimentation rate post-operatively may explain the delayed bleeding in some of these cases, and also indicate the possible value of post-operative determinations.

CASE II.—Chart II represents the same data in the case of a woman of thirty-nine years who entered because of a draining biliary sinus of two months' duration, due to a stone in the common bile duct. This patient was not jaundiced clinically. The serum bilirubin was too low to be estimated quantitatively. The icterus index, however, was 17 on admission. This is about twice the normal value, but only represents a low degree of jaundice. The sedimentation rate and coagulation time were normal on admission. Laparotomy under ether anaesthesia, with removal of a stone, was done twelve days later. As already noted, if the sedimentation rate had been done, just previous to the operation, I believe it would have been found to be much more rapid than the initial determination. Thus the day following, after bleeding from the wound

had been noted, the rate was very rapid. Coincidental with this there was practically no increase in the clotting time despite the bleeding.

Following transfusion the bleeding gradually stopped and the sedimentation rate decreased from 48 to 24 millimetres. There was no more bleeding and on the twenty-second day post-operatively the rate was 29 millimetres, still relatively slow.

*Comment.*—Here again the sedimentation rate was high during the bleeding. When this was stopped, with the aid of transfusion, there was a corresponding drop in the rate. The coagulation time on the other hand was normal even during the time bleeding was taking place. In addition, it is interesting to note that this patient represents the type that may bleed without a high grade of jaundice, indicating it is not the bilirubin *per se* in the blood which causes the bleeding.

CASE III.—Chart III shows the findings in a man of forty-seven years with carcinoma of the head of the pancreas with obstructive jaundice who also had ascites.

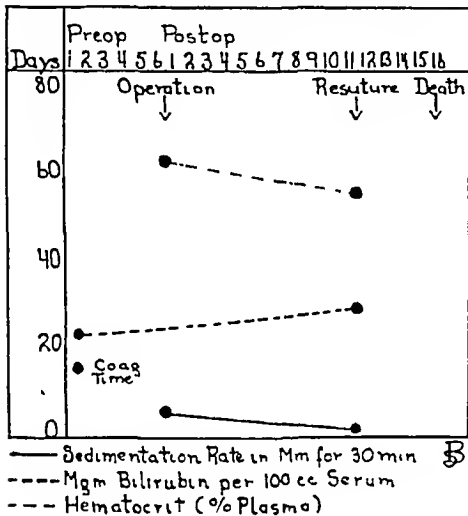


CHART III

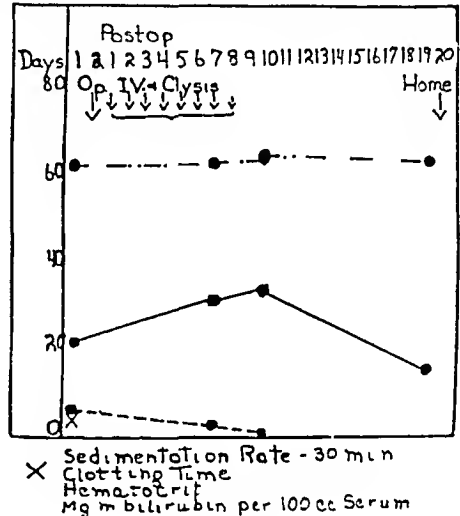


CHART IV

Pre-operative determination of the coagulation time showed slight elevation above normal, while the sedimentation rate was very slow. An exploratory laparotomy was done under spinal anaesthesia. A very extensive carcinoma with a great many metastases was found. A biopsy was obtained and the abdomen closed. The convalescence was uneventful except for a reaccumulation of the ascites, and the eleventh day post-operatively the wound broke open. Resuture of the wound was done under local anaesthesia. No abnormal bleeding occurred although it was expected, since the patient had not been relieved by the primary operation, and his jaundice had increased. The sedimentation rate taken before the resuturing was later found to be extremely slow, only 2 millimetres in half an hour. The patient died on the sixteenth day post-operatively. Necropsy revealed no evidence of hæmorrhage.

*Comment.*—Despite a delayed coagulation time in an intensely jaundiced man, there was no post-operative bleeding. The sedimentation rate on the other hand remained very slow, indicating that hæmorrhage, even from the secondary operation, was unlikely. In addition it should be stated that this patient received no  $\text{CaCl}_2$ , either by mouth or intravenously, nor transfusion in preparation for operation. At the time the wound was resutured the

## BLOOD SEDIMENTATION AN INDEX OF HÆMORRHAGE

bilirubin in the blood had risen to 30 milligrams per 100 cubic centimetres of serum. This is one of the highest figures I have seen. Despite this fact he did not bleed, indicating again it is not the amount of bilirubin in the blood which is the cause of the bleeding.

CASE IV.—Chart IV represents the findings in a woman of forty-eight years who entered the hospital because of jaundice of two and one-half months' duration, due to stones impacted in the common bile duct. Operation was performed under ether anæsthesia soon after entry. The pre-operative sedimentation rate was not rapid. The coagulation time was normal. No special pre-operative preparation was instituted, such as intravenous  $\text{CaCl}_2$  or transfusion. The convalescence was uneventful except for early nausea and vomiting which was treated with intravenous glucose and hypodermoclysis. The sedimentation rate post-operatively did show some tendency to increase, but this was not marked. There was at no time any indication of post-operative bleeding.

*Comment.*—Here again, a relatively slow pre-operative sedimentation rate in the presence of a long-standing obstructive jaundice, indicated that immediate post-operative hæmorrhage would probably not occur. Also the fact it had not increased much post-operatively indicated that delayed bleeding was unlikely.

### SUMMARY

The surgical treatment of severe obstructive jaundice is not unfrequently complicated by immediate or delayed post-operative hæmorrhage. It is, therefore, of great practical importance to detect before operation, which patients are likely to bleed in order to take measures to correct this bleeding tendency.

The unreliability of available tests for the detection of this bleeding tendency prior to operation, has been pointed out. Post-operative hæmorrhage was found to be in no way dependent on the degree or duration of the jaundice.

The sedimentation rate of the blood in a series of cases with obstructive jaundice is reviewed and the results correlated in reference to post-operative hæmorrhage. It is also compared with the coagulation and bleeding times of the blood in these same cases. The sedimentation rate of the blood, like the white count, is influenced by many diseases. This test is not specific nor diagnostic for any disease, but along with other data it is a valuable addition to the laboratory tests. Fevers as a rule cause a marked increase in the sedimentation rate. Because of this I wish to point out that all of the cases, with the exception of Case 4, Charts I and III, and Case 9, Chart II, in which I have reported rapid rates, have been practically afebrile. I have arbitrarily chosen a sedimentation rate of less than 30 millimetres in half an hour, according to the method used above, as a "slow" rate and one which is higher than 30 millimetres, as a "rapid" rate.

When the sedimentation rate in cases of obstructive jaundice was found immediately prior to operation to be slow, early post-operative bleeding did not occur. Furthermore, bleeding, either immediate or delayed, did not occur as long as the sedimentation rate remained slow. Three of the four



cases which had rapid rates pre-operatively bled immediately following operation despite pre-operative preparation. All patients who bled showed rapid rates at the time the bleeding was taking place.

Blood transfusion is the best known method of checking this type of post-operative hæmorrhage. Accordingly, following transfusion in these patients there was a drop in the sedimentation rate, which varied from a few millimetres in some cases to twenty or thirty millimetres in others. The bleeding always stopped when the sedimentation rate became slow.

#### CONCLUSIONS

1. Pre-operative and post-operative determinations of the coagulation and bleeding times are not reliable indices of the hæmorrhagic tendency in obstructive jaundice.
2. The bleeding tendency is not dependent alone on the degree nor the duration of the obstructive jaundice.
3. The sedimentation rate of the blood is a more reliable test of this hæmorrhagic tendency than the others now available.
4. Patients with obstructive jaundice who have a slow sedimentation rate are unlikely to bleed post-operatively, and those with a rapid rate in the absence of fever are apt to bleed.

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# THE SURGICAL IMPORTANCE OF THE OMENTUM\*

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IN THE social fabric of all organisms, from the highest to the lowest, whether animal or vegetable, whether sessile or motile—from the mammals to the corals, *protection* is all important. It ranks next in importance to reproduction itself and is much more diverse and varied in form. Its failure accounts for the obliteration of millions of species. Read what that master interpreter of life, Maeterlinck,<sup>1</sup> writes of protection among those lowly, ancient insects who have achieved millions of years of life as a species because of a highly specialized form of social life, the termites. Consider his interpretation of the sacrifice of the individual upon the altar of this tremendous economic urge! Well might one inquire in contemplating the individual life as compared with that of the tribe—What price safety?

There hangs in the Harvard Club of New York a stately specimen of the antlers of the Irish elk, dug recently from the peat bog which had immured the hapless creature some millions of years ago, when Ireland was still a part of the mainland. These great horns visualize to the thoughtful observer the fatal effects, upon race and individual alike, of the overemphasis or overdevelopment of any one organ. Overspecialization tends to extinction even in matters of protection! These great antlers, more than twice the size of today's moose, elk or caribou, in response to a growth-urge run riot, developed upon an animal no larger than our common deer. Not only did the yearly growth exhaust the individual's strength but these huge horns, devised especially for protection, actually came to interfere with successful quest for food to such a degree that the entire race died from starvation!

It is important to remember that by no means all structural arrangements in the human body have been benefited by signal changes in racial habit. Consider the postural habit. Man's election to assume the upright position, probably primarily protective in origin, has of course been of inestimable help in his development, yet in many details it has been far from helpful. Think of the yearnings of the gastrointestinal invalid for a return to the quadruped position—does he not instinctively sleep upon the abdomen—of the ill effects of gravity upon the female pelvis and upon the inguen of both sexes! Consider finally even so small a detail as the deficient drainage of the antrum of Highmore! How evident it is that chronic antritis accompanied by a cesspool of pus in the low lying angle, with its far-reaching sequelæ in the alimentary canal, notably diarrhoea, is directly the result

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\* Read before the Orange County Medical Society, Florida, February 19, 1930.

of man's upright position. Were he still a quadruped the nasal orifice would be so placed as to give perfect drainage.

In no department of human thought or endeavor is it so important to be sure of the accuracy both of premises and of evidence as in that which seeks to diagnose human ills. Thus only can one hope to arrive at the fundamental cause, at the truth. Thus only can one hope to avoid the oft-repeated but cruel error of blaming the patient for exhibiting symptoms quite beyond his control, all a part of his aberrant protective mechanism and due to physical defects unrecognized by ourselves. That this mechanism may be awry and out of bounds is nature's shortcoming, not his. Is a patient ill because he has mucus in his stools, or is this an integral and important part of nature's protective mechanism? Obviously it is the latter. What is fever, diarrhœa, constipation, vomiting, fainting—what is all pain and all disability but an expression of an ever-present protective mechanism!

As I see it, no one is in greater need of pondering upon these matters than the abdominal surgeon, for within his field there lies a generally overlooked and as yet uninterpreted organ, the omentum. In part because of its relative lack of differentiation as compared with the other abdominal viscera, its morphological variability, which is often of surprising extent, and its retention of many primitive characteristics, the function of the omentum though carefully and rather intensively studied is as yet little understood. In this respect the omentum bears some resemblance to the spleen, with the development of which it has close embryological relationship. The equally important question as to its pathogenicity, a field of great breadth and of deep interest, until recently has been given no attention whatsoever.

Poynter,<sup>2</sup> reviewing omental development, says that the mesogaster begins as a supporting ligament for the stomach, but through overgrowth and change of position ceases to function in that capacity and undergoes structural changes suggesting in some respects degeneration and in others specialization of function. Careful correlation between the X-ray studies of Redford K. Johnson and my own operative work supports the belief that certain interesting anomalies of the omentum are frequently so much at variance with the necessary anatomical and physiological standards as to render that structure a serious menace to health.

We have all been brought up to believe that the omentum is the most important protective structure in the abdomen, that by virtue of what has been called positive chemotaxis or facultative amœboidism it has the inherent power to migrate toward any portion of the peritoneal cavity where traumatism or infection is located. These views were derived from a period in medical history in which the deductions of speculative imagination had not yet given place to more accurate if less picturesque experimental findings.

Rubin<sup>3</sup> introduces the subject of his experimental researches upon the omentum by a consideration of the comparative omental anatomy in the lower forms. "The habits and stage of evolution of the animals," he says, "determine to a certain extent the development of the omentum. It is absent

in the fish. Its first indication is seen in the lowest form of vertebrates, the giant salamander. Birds have a very primitive omentum. Dogs, cats and domestic carnivorous animals have a remarkable development of this structure. The omentum in monkeys shows the nearest approach to that of man; in some it is attached to the transverse colon. Its embryological development is bound up with that of the stomach and the spleen." The chief function of the omentum appears to be to form adhesions, to engulf bodies placed in the peritoneum and which are too large to be ejected into the blood-stream, to absorb particulate solutions, and finally, to absorb via the blood-stream toxins from the peritoneal cavity. These toxins may be either endogenous or exogenous in type, that is to say, arising from damaged intestinal mucosa or from the too-abundant growth of intra-enteric bacteria.

Ewing<sup>4</sup> has demonstrated that the intestinal walls beneath and adjacent to omental pressure bands may become so attenuated as to consist of little save the serosa and has stated that a gut in this condition would be permeable to its contents. Rubin's studies upon the absorptive action of the omentum are therefore of great significance. Cats he found to have a relatively large omentum. It measures from two hundred and twenty-five to five hundred square centimetres. In a considerable series he resected the omenta and injected indigo carmine intraperitoneally. Blue urine appeared in from forty to sixty minutes. In the control series of cats with omenta intact it appeared in from twelve to fifteen minutes. It would appear, therefore, that the omentum is the chief absorbing agent in the peritoneum, and that its removal causes a fourfold delay in peritoneal absorption. These observations are of vital importance in connection with omentectomy as practised by us in more than two hundred human patients, serving to explain or at least to give a workable hypothesis as to the cause of the systemic and often immediate clinical improvement noted in cases of so-called chronic intestinal toxæmia. It would seem that the removal of the omentum may help to block the entry of the toxins into the circulation. Finally, Rubin concludes that the omentum has no spontaneous motility, no chemotaxis, no intelligent and spontaneous protective rôle. It cannot restore vitality nor vascular supply. The end-product of an adhesion between the omentum and any other abdominal viscus is scar tissue. It does not invariably and spontaneously repair defects in the viscera. It is useful in certain respects. "But when contrasted with the sequelæ, *intestinal obstruction, pain, etc., its beneficence is overbalanced.*"

Shipley and Cunningham<sup>5</sup> state that the omentum plays a very large part in the actual drainage of the peritoneal cavity. "True and pseudo solutions and granules of particulate material find their way through omental vessels to the organs of the body destined for their ultimate reception and storage, or destruction and excretion, *and the path by which they leave the omentum is not a lymphatic but a hæmic one.*" Poynter, after having referred to the experimental proof that the omentum acts differently from

other peritoneal surfaces, and that through it particulate matter and solutions are taken up from the peritoneal cavity and enter the blood-stream, makes this significant statement: "There seems to be little doubt that *bacteria and toxins are taken up in the same way . . .* the omentum is the avenue through which the peritoneal contents reach the blood stream most directly. . . . It is interesting to think that a structure so long known and so thoroughly studied should be so little understood. Radical surgery has proved that it is not indispensable to individual well being."

Warren T. Vaughan,<sup>6</sup> in discussing the results of an extensive study upon the reaction of the omentum, concludes that, "aside from the ability of the omentum to gather up free particles from within the peritoneal cavity, the gross and microscopic reaction to foreign germ substance does not differ essentially from such reaction in other tissues of the body, whose functions are not so clearly protective. The paucity of detail in standard reference works on the physiology and pathology of the omentum is remarkable. The omentum is an organ of no mean importance, further knowledge of which should be productive, not only to the surgeon and pathologist, but likewise to the immunologist."

John Bryant<sup>7</sup> has made a classical contribution to the morphology of the omentum. His discussion on "Poor Health in the Child; Some Developmental Influences and Their Importance to the Adult" is not as generally known as it later will be. While it is true that in his study he did not discriminate in the foetus between adhesions of omental or purely peritoneal type it is probable that many of the prenatal adhesions described by him were due to embryological anomalies in the omentum. The important conclusion in his paper is that "adhesions, ptosis, and other demonstrable physical defects are of very common occurrence at all ages in both sexes, but the frequency of these defects in the adult is not markedly greater than in the child. It is not improbable that such defects may stand in a causal relation to some, at least, of the disabilities of the child and the adult." In a later paper on visceral adhesions and bands Bryant<sup>8,9</sup> says: "The frequency of adhesions or bands in the fetus of both sexes has been greatly underestimated. Only 5.9 per cent. were free from them. The transverse colon is more frequently involved by adhesions than any other abdominal viscus. Seven women and eight men out of every ten persons presumably have some involvement of this viscus by congenital or acquired adhesions. The distinguishing characteristics of congenital or developmental adhesions, are simplicity and lack of variety of type. The distinguishing characteristics of acquired adhesions are complexity and variety in type."

Draper and Johnson,<sup>10</sup> discussing their early studies on the pathogenicity of the omentum, state that, "congenital defects of the omentum may so alter its form as to destroy its protective mechanism and make it a menace to life. . . . Moreover, the fact that an immense amount of human disability is directly traceable to the pressure of omental bands accentuates the interest of the clinician in their very obscure origin and pathogenic properties." After

discussing the hereditivity of these omental deviants in the course of which they found unmistakable evidence that omental abnormalities are often handed down from ancestor to child, in accordance with the Mendelian law, they conclude, that, "omental bands may exercise angulating and injurious pressure on the colon. If present, they are bilaterally symmetrical in more than fifty per cent. of all cases. They are caused by interference with or irregularities of the developmental impulses in early embryonic life. . . . Special effort should be made in children to find and remove them before the colon has been irreparably injured."

The same writers,<sup>11</sup> discussing the pathogenicity of the colon, say: "True elbow deformities of the transverse colon, the majority of which are due to omental dysmorphism, usually combine in varying degree torsion and pressure . . . the end result is a physical and neuromuscular disturbance of function. Long continued pressure, leading to progressive damage to the colon wall so as to render it permeable serves to augment the inflammatory reaction in the peritoneum, and a vicious circle is thus established."

The question of pathogenicity has already of necessity been broached in the foregoing discussion of omental morphology. The very fact of the newness of this study, and also the fact that it is somewhat disquieting to find or even to seek for pathogenicity in an organ which until now has been looked upon as having only a protective rôle, excludes any dogmatic conclusions as to the character and extent of its pathogenesis. In the treatment of somewhat more than two hundred cases during the past five years, I have removed the entire omentum without immediate or late prejudice to the patient. This was done only if and when such removal seemed clearly indicated by the X-ray proof of the presence of omental deviants exerting pressure upon the bowel. The justification for such removal is the same as for the excision of any other abdominal viscus, namely, that because of disease it has become more dangerous than valuable to the individual.

From the consideration of the physiology and the morphology of the omentum, as already related, it is evident that this little understood structure is the chief factor in draining the peritoneum; that this drainage passes, not into the lymphatics, but directly into the blood-vessels; that omental excision reduces such drainage fourfold, though this may be compensated for later; that omental deviants or directional abnormalities may cause mutilating pressure upon the gut, chiefly the colon, terminal ileum and duodenum; and that through this damaged gut both endo- and exo-toxins are known to pass and to be carried largely by the omentum directly into the body cavity via the blood-stream. Is the omentum therefore as important to the human economy as heretofore generally supposed? The studies of Johnson and myself indicate not only that it is not, but also that interruption of peritoneal drainage under the condition cited and by excision of this chief drain may be of great clinical value to the gastrointestinal invalid. We have concluded that this physiological factor, this drain-block, together with the mechanical release of damaging omental pressure upon the gut, helps to

explain the enigmatic improvement so often noted in the surgical treatment of such differing disorders as epilepsy, diabetes insipidus, arthritis, dementia præcox in its early stages, neurasthenia, hay fever, asthma, non-specific skin disorders, personality changes and behavioristic abnormalities in children, and other ailments. We feel sure that the relief of the chronic constipation *as such* is of small moment compared to the other less apparent but important physiological benefits brought about by the operative procedure. For in some patients the constipation has remained essentially unchanged whereas the remote symptoms have been alleviated. If by further study our deductions are shown to be correct in trend if not in all details, it will be evident that, like fire, the omentum can be at least as potent for evil as for good, that its protective mechanism can be so highly specialized as often to do more harm than good, and that its removal will be indicated under many and for widely differing conditions. Meanwhile, the pathogenicity of this little-known structure will continue to interest increasingly all students of the pathological physiology of the abdomen.

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## INTUSSUSCEPTION COMPLICATING VISCERAL (HENOCH'S) PURPURA

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THE various sorts of purpura have as their common and basic sign, hæmorrhages into the skin. These hæmorrhages vary in different patients as to severity, distribution and form, and the cases observed clinically differ from one another by various other manifestations which have caused the affection to be split up into the well-known clinical types. Simple, arthritic, and intestinal purpura are described and such names as morbus maculosus (Werlhof) peliosis rheumatica (Schonlein), Henoch's purpura, purpura simplex, purpura hæmorrhagica, and purpura fulminans have been used for the different types. Some of the names obviously are given according to the organ most affected by the bleeding, which may be justified by attention being drawn to the main symptom, intestinal bleeding, bleeding into the joints, etc., but essentially this differentiation is not right as severe bleeding from one organ or another may happen in any type.

Purpura is also frequently noted as a complication of various acute infections and chronic cachexias. The idiopathic types, that is those not manifestly complicating some other primary disease, should probably be thought of as a single group even though the sub-group designations such as Schonlein's disease and morbus Werlhofii are useful as emphasizing certain symptoms and indicating the prognosis. The type known as Henoch's purpura, or intestinal purpura, or purpura with colic, is commonly a more severe and extensive type of arthritic purpura although some of these cases are without joint involvement.

Many accounts of Henoch's purpura give the impression that the pains and acute abdominal rigidity are always functional in origin and warn against operative intervention. This reaction of the abdominal muscles to bleeding in an intestine often creates the impression that we may have to deal with an acute surgical abdomen, intestinal obstruction, acute appendicitis, etc.

While it is true that many purpuras with colic do not have an actual obstructive lesion and that the intestinal rigidity finally resolves, cases exist in which operative intervention is imperative for the relief of actual intussusception. These facts have already been reported by Tonking, Lett, Barling and others and the following case further emphasizes them.

J. L., male, age thirty-one years, was admitted to Harper Hospital August 22, 1929. His previous history was of no special significance. He entered the hospital on account of pain in the abdomen which had existed for about two weeks. There was some swelling in his forearms, and the muscles of his legs seemed swollen, and red blotches appeared on his legs. Several times during the two weeks preceding his hospital entrance he had severe intestinal cramps. Four days before admission he passed fresh



blood from the bowel and vomited about one-half pint of coffee-ground material. When admitted to the hospital he had typical petechiæ on lower legs, ankles, feet, trunk and upper arms, with blood findings of severe secondary anæmia. The platelet count varied from 250,000 to 350,000 with normal bleeding time. There were red blood cells in his urine. Bowels moved intermittently, and then again he had severe constipation with intestinal pain.

To the right of the median line a long tumor mass resembling an intussusception could be palpated. Following various textbook accounts which warned against operation on the ground that visceral purpura was often taken for intussusception, the man was left undisturbed under the impression that purpura alone caused all his trouble. On August 28, however, he had such a typical attack of severe intestinal pain, as in obstruction, with visible peristaltic wave, and blood and mucus coming from his rectum, and the appearance of a tumor mass in the right abdomen that opening of the abdomen was strictly indicated. The section through a six-inch right rectus incision revealed the transverse colon very much dilated and a twelve-inch-long intussusception of the ileum into the cæcum going well beyond the hepatic flexure. The intussusception was reduced, the appendix removed and the ileum and cæcum paralleled one to the other by a few interrupted catgut sutures to prevent recurrence of the intussusception. He made a good recovery. The bleeding diminished and although rather pale, he left the hospital September 11 much improved. September 24 he had severe weakness and another attack of purpura and was re-admitted to the hospital. In spite of the usual treatment for purpura, transfusions, calcium, and parathormone, etc., he went from bad to worse, with the occurrence of hæmaturia and new intestinal symptoms. The non-protein nitrogen steadily increased, reaching 120 milligrams. He died two months after the second admission to the hospital.

The following is taken from autopsy report: "The abdomen presents no marked distention. A mass is felt on palpation in the epigastric area. On opening the abdomen, it is found to be full of fluid (sero-purulent type). A large mass of omentum is adhered to the abdominal wall in the area of previous operative scar. The spleen is about mid-line of the epigastric area, not increased in size to any considerable extent, but is markedly stained a cyanotic color due to pseudomelanosis. The stomach is of normal size, the anterior surface covered with hæmorrhagic areas. The posterior surface appears to be normal."

*Intestines.*—There are marked diffuse sub-peritoneal hæmorrhages of the entire gut with the exception of the splenic flexure. There are numerous smaller areas of hæmorrhage and large diffuse subperitoneal hæmorrhages causing the gut to appear gangrenous, especially in the ileum. The terminal portion of the ileum lay parallel to the cæcum. In the mid-portion of the ileum there are several perforations ranging in size from that of a fourth to a half centimetre in diameter. The peritoneum is covered with a purulent fibrinous material.

There were no significant gross or microscopical changes in the kidneys. It is likely that the increase in the nitrogen level was of intestinal origin and similar to that found in intestinal obstruction.

The liver showed round-cell infiltration and thickening of the liver capsule. There were areas of diffuse round-cell infiltration in liver lobules. Irregularity in size and staining properties of liver cells showed reaction to injury.

The cases classified under the designation, Henoch's purpura, have acute gastro-intestinal symptoms, abdominal pain, vomiting, blood and mucous stools, also hæmaturia and marked albuminuria. Curiously enough these symptoms often come on after the skin lesions have subsided or before they appear and the purpuric nature of the affection may be unsuspected. On account of the embolus or thrombosis of the mesenteric vessels, obstruction or intus-

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susception is often diagnosed; but it is now well known, and the case here reported illustrates that the local thickening of the bowel wall resulting from the serohæmorrhagic œdema characteristic of intestinal purpura may lead to actual intussusception.

The mechanism is probably identical with that of the intussusception resulting from intestinal polyps or any intra-mural swelling of the bowel wall from any cause. (See Figs. 1 and 2.)

The descending faecal column pushes the abnormal segment of bowel into the distal normal portion and produces the intussusception.

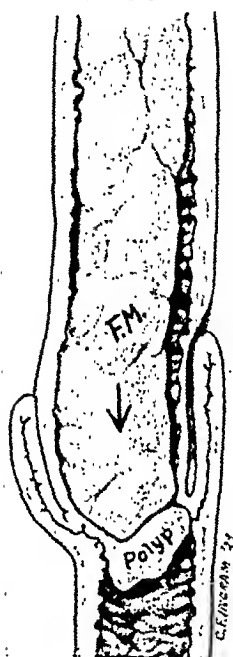


FIG. 1.—Shows how the advancing column of intestinal contents (F.M.) impinging on a polyp may cause an intussusception.



FIG. 2.—Shows the collar of thickening of bowel wall due to hæmorrhage in intestinal purpura.

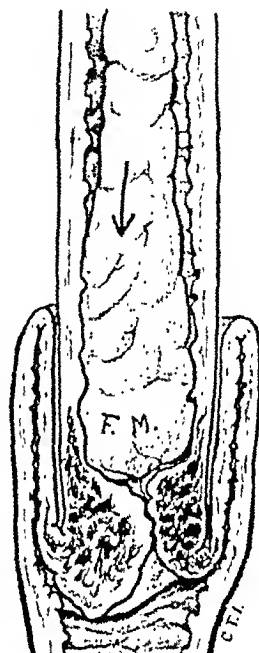


FIG. 3.—Shows how such hæmorrhage may lead to intussusception just as in the case of intestinal polyp.

### CONCLUSIONS

1. Intestinal purpura may produce symptoms resembling intestinal obstruction or intussusception by causing intestinal paresis and so simulating obstruction and this obstruction may resemble intussusception by the escape of blood from the purpura through the rectum.

2. On the other hand, an actual intussusception may be caused by a thickening of the intestines caused by hæmorrhage from the purpura being invaginated into the bowel below just as intestinal polypoid tumor will cause an intussusception.

3. The presence of obstructive symptoms with intestinal purpura, therefore, requires great judgment in determining whether an actual intussusception is present or only intestinal rigidity caused by the hæmorrhages. Obviously, an intussusception requires surgical interference even in the presence of purpura, as such complication, although dangerous, is not necessarily fatal.

# THE MORTALITY FROM APPENDICITIS \*

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AT THE 1910 session of the German Surgical Congress Kuttner stated that he had personally suffered from recurrent appendicitis for eleven years. There was a last attack in June, 1906, following which he took some castor oil; in one-half hour the pain increased and vomiting appeared together with chills and fever. Sixteen hours after taking the oil operation was performed and the appendix found gangrenous with progressive peritonitis. Conse-

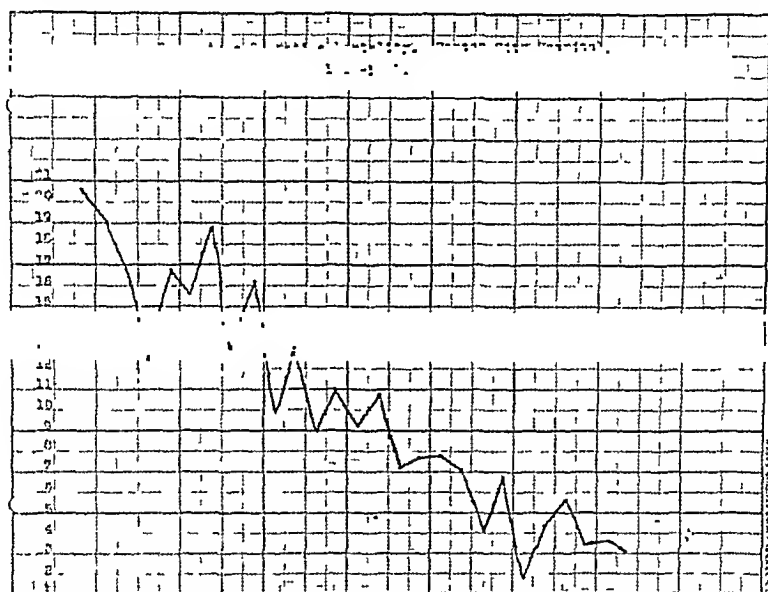


FIG. 1.—Percentage Operative Mortality, Boston City Hospital, 1895-1922.

quently he did not hold this treatment in very high favor and was of the opinion that it should be abandoned.<sup>1</sup> Nineteen years have passed and the subject has been taught, discussed and impressed upon us by the leaders in surgery who have seen the development of this subject to its present high standard of efficiency and who have materially assisted in the marked decrease which has occurred in the operative mortality. Dugan,<sup>2</sup> reporting the operative mortality at the Boston City Hospital, shows that in 1895 it was 20.7 per cent. and in 1922 it was 3.1 per cent. The number of patients operated upon in 1895 was eighty-two and in 1922 was 903. The number of patients who died in 1895 was sixteen and in 1922 was twenty-seven; showing that although the operative mortality had markedly decreased the actual number of people dying was greater.

In a personal communication from the Metropolitan Life Insurance Com-

\* Read before the Philadelphia Academy of Surgery, January 7, 1930.

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pany I find that their mortality in 1911 was 10.9 per cent. per 100,000 and in 1928 it was 13.7 per cent. A review of the deaths from this disease in Philadelphia shows that in 1923 there were 328 and in 1928 there were 300. The mortality in our city in 1928 was 81 per cent. higher than in 1923 in the patients between two and five years of age. Between five and ten years of age the mortality in 1928 was 47 per cent. higher than in 1923. The mortality between ten and fifteen years of age has remained the same and over fifteen years of age has decreased 18 per cent. We are, therefore, confronted with an advancing mortality between the ages of two and ten years; however, our total death rate per 100,000 is decreasing. In 1926 it was 16.4 per cent. and in 1927 it was 14.9 per cent. With the total deaths of 300 for 1928 the per-

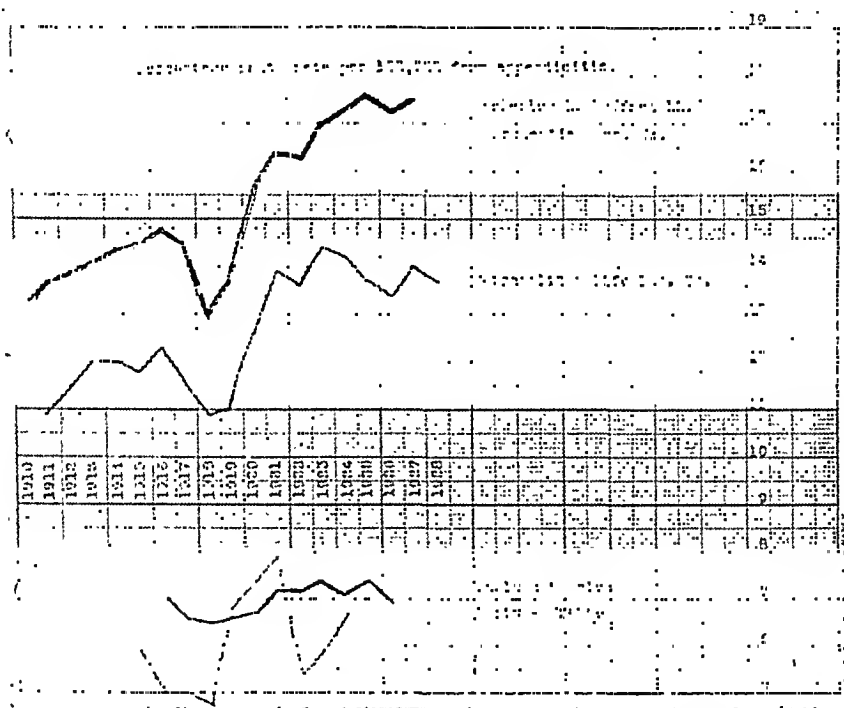


FIG. 2.—The percentage death rate per 100,000 from appendicitis, 1910-1928.

centage for this year will probably be lower than in 1927. In reviewing "The Appendicitis Record of 1927" by Frederick L. Hoffman,<sup>3</sup> LL.D., consulting statistician of the Prudential Insurance Company of America, I am impressed with the growing mortality from this disease throughout the United States. In a study of sixty cities the death rate per 100,000 has increased from 13.3 per cent. in 1910 to 17.6 per cent. in 1925. This increase has been consistently progressive with the exception of the years 1918 and 1919. A comparison of the year 1924 shows that our mortality was 17.3 per cent., the mortality in Paris, France, was 6.79 per cent. and the mortality in England and Wales was 7.1 per cent.

After discussing the mortality Mr. Hoffman asks the question: "Who is to blame?" and adds that it is of vital concern to life insurance companies, which in a large proportion of cases pay the claims on victims of what is obviously indicated as a failure on the part of the medical and surgical profession in the judgment of the foremost authorities on the subject. He quotes

Doctor Deaver <sup>4</sup> in his address before the Pittsburgh Academy of Medicine, February 28, 1928, to the effect that the important factors in the present high mortality are precipitate operation in the presence of peritonitis and not removing the appendix that has recovered from an acute attack. Dr. Charles Mayo <sup>5</sup> in referring to the increasing mortality is of the opinion that it is due to the fact that the younger generation of practitioners, who did not benefit by the early period of discussion, have not recognized the seriousness of such infections, and, therefore, have not made haste to diagnose and operate early in these cases. Too many operations are performed during the dangerous intermediate period between early and late infection, and possibly too much is attempted in the late operation when there is an abscess. Thus the surgeons for each period must discuss the subject and clarify it for themselves, since human experience, which affords opportunity for progress, can be passed on only to a limited extent.

It is with this thought that I am reporting this group of 100 cases of acute appendicitis admitted to my service at the Misericordia Hospital. Although I am aware that the group is small, I trust that it will show that as one of the younger generation of surgeons I am cognizant of the vast importance of this subject. The cases were consecutive admissions over a two-year period, including gangrene, abscess and diffuse peritonitis. There were four deaths. Two were from diffuse peritonitis, one from cardiac dilatation and one from hepatic abscesses. In the death from hepatic abscesses a second operation evacuated one large abscess but there were numerous small collections of pus throughout the whole liver.

In reviewing the mortality of comparable groups I find that Colp <sup>6</sup> reports 2841 cases operated at the Mt. Sinai Hospital, New York, with a mortality of 5.2 per cent. Wilensky, <sup>7</sup> reviewing this subject in *Progressive Medicine*, quotes Marsch with a mortality of 4.5 per cent.; Nather 4 per cent.; Hoffman 6.8 per cent.; Suermondt 7.8 per cent.; Schaer, 4.1 per cent.

Eliason and Ferguson <sup>10</sup> report 675 cases with a mortality of 5.3 per cent.

Muller <sup>11</sup> reports 101 cases with five deaths, a mortality of 4.9 per cent.

The mortality in 165 of Schaer's reported cases of appendiceal abscess was 7.8 per cent. and in seventy-two cases of diffuse peritonitis was 56.9 per cent. Ashhurst <sup>8</sup> reports 247 complicated cases of appendicitis with a total mortality of 13.7 per cent. In this group there were forty complicated cases.

In analyzing the symptoms of these 100 cases I find that 91 per cent. of the patients complained of pain in the right iliac fossa. Only 8 per cent. had generalized abdominal pain and one case suffered pain in the left iliac region. Although it is generally stated that the pain may be located in any portion of the abdomen we must not lose sight of the great importance of pain in the right iliac fossa which is exaggerated by pressure or coughing. In a number of instances in this group I would have made mistakes in diagnosis if I had not depended upon this early, consistent and reliable finding. The pain is the result of swelling of the mucosa and strangulation of this struc-

ture by the elastic fibres of the appendix. It occurs from three to twenty-four hours before the appearance of temperature or leucocytosis.

Leucocytosis was the next most consistent finding and occurred in 88 per cent. of the cases. Six to eight thousand was accepted as normal in this study. The importance of this finding should not be underestimated although it is corroborative and should not affect our diagnosis to too great an extent. It is the result of absorption of toxins and not necessarily an evidence of the amount of pathology to be found.

The pulse rate was increased in 87 per cent. of the cases and the temperature was above normal in 83 per cent. The pulse rate usually advances with the increase in temperature. The temperature is the result of absorption of toxins and is not an indication of the amount of the pathology. Nausea was recorded in 55 per cent. of the cases and vomiting in 46 per cent. The urine contained albumin in 47 per cent. of the cases and pus in 8 per cent. Rigidity was recorded by the interne in 60 per cent. The pathological diagnosis agreed with the clinical in 90 per cent. A McBurney incision was used in eighty cases and a right rectus in the remaining twenty. I have not been able to find any statistics with reference to the mortality which would indicate that one is superior to the other but it is my impression that the appendix can be more easily removed and drainage most effectually instituted with a McBurney incision. The application of drainage outside of the cæcum and small bowel should reduce the incidence of intestinal obstruction. No case of mechanical obstruction occurred in this group.

Nitrous oxide in combination with novocaine and ether was used in 71 per cent. of the cases; ether was used on eighteen occasions; ethylene was used once; novocaine alone in four and spinal anæsthesia was used six times. I have been using novocaine crystals dissolved in spinal fluid and have found it to be a very satisfactory anæsthetic; however, I will admit that I always use it with a certain amount of hesitancy unless I can assure myself that the advantages to the particular case will overbalance the disadvantages of the anæsthetic.

#### CONCLUSIONS

1. A study of the mortality from acute appendicitis in the United States shows that it is consistently increasing.
2. One hundred consecutive cases of acute appendicitis are reported with a mortality of 4 per cent. Based upon the pathological findings the mortality is 4.4 per cent.

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# SUPPURATIVE RETROPERITONEAL PELVIC LYMPHADENITIS\*

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INFECTION and suppuration in the glands of the retroperitoneal pelvic region due to causes other than tuberculosis are not as infrequent an occurrence as one would surmise from a review of the literature. It is rather surprising to find in a rather comprehensive study of this subject comparatively few publications during the past twenty years. On the other hand, in looking over the Mount Sinai Hospital records covering the last decade, twenty-one cases of this disease were found. The reason for its apparently rare occurrence probably lies in the fact that the symptoms are often very vague at the onset and the condition is mistaken for hip-joint disease, Pott's disease, osteomyelitis, and inflammatory diseases of the abdominal viscera (such as appendicitis) and of the pelvic organs. Its true nature is thus frequently overlooked for a time. In fact, in some of the reported cases the diagnosis was made only after the abscess had ruptured spontaneously, or as a post-mortem finding.

The retroperitoneal space lies immediately behind and outside of the peritoneal cavity, and may be divided roughly into a lumbar and a pelvic portion. When the lumbar area is involved, the symptoms are easily confused with those of perinephric and subphrenic abscess. The space itself is well supplied with a complete network of lymph channels and vessels, which extends from the diaphragm to the lowest part of the pelvic cavity. The lymph nodes of this region are divided into three groups: the mesenteric, the lumbar, and the iliac. The latter two groups are situated on both sides of the vertebral column and communicate with the lymph channels of the alimentary tract, the female pelvic organs, and the lower extremities. Here we have the explanation of the fact that infection in the retroperitoneal space generally originates in one of these sources (intestinal tract, pelvic organs, or lower extremities).

In a study of the published case reports one is impressed by the frequency with which the etiological factor remains obscure. The most common causes of retroperitoneal lymphadenitis are tuberculosis, typhoid fever, appendicitis, trauma, metastatic blood infections, and suppuration in the inguinal glands and pelvic organs, especially following labor or abortion.

In the twenty-one cases I have had the opportunity of studying the age incidence was as follows:

First decade .....	8 cases
Second decade .....	4 cases
Third decade .....	6 cases
Fourth decade .....	1 case
Fifth decade .....	1 case
Sixth decade .....	1 case

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\* Read before the New York Surgical Society, February 26, 1930.

The distribution as to sex was almost equal, eleven males and ten females. This is greatly at variance with published statistics, where the proportion in the female is considerably higher, according to some authors 32:4. In eighteen cases an etiological factor could be fairly definitely ascertained; in three the causal relationship was very vague and questionable. The conditions which preceded the onset of the retroperitoneal infection may be summarized as follows:

Appendicitis, 5 cases; metastatic blood infections, from furunculosis, otitis media and upper respiratory tract infections, 4 cases; distinct history of trauma on side involved, 2 cases; infections on lower extremities, 2 cases; diverticulitis, 1 case; foreign body (fish bone in colon), 1 case; gastroenteritis, 1 case; miscarriage, 1 case; diseased adnexa, 1 case. Briefly, the etiological factors were: A previous suppurative appendicitis was found to be the causative agent in five cases. In two of these the appendix had ruptured, with abscess formation; in three drainage had been instituted. In all cases except one the original appendix incision was healed and the patients had been free from fever or other symptoms for varying periods. Under such conditions it can readily be realized that the diagnosis might remain obscure for some time. The persistence of an unexplained fever following acute appendicitis, however, should make one suspicious of retroperitoneal involvement.

In four cases the infection was undoubtedly hæmatogenous in origin, following respiratory tract infections, otitis media, and furunculosis. A period of months elapsed in several cases before symptoms of retroperitoneal infection supervened.

That injury plays a definite rôle was evidenced in two instances of falling and striking the affected side followed within a few weeks by the development of retroperitoneal symptoms on this side. Very likely in these cases there was at first formation of a hæmatoma which subsequently became infected. The relationship to the other etiological factors above enumerated can readily be seen.

It is sometimes impossible to ascertain the source of the infection. This happened in three of our cases. With a history which fails to point to infection in the neighboring intraperitoneal or pelvic organs or any of the other causes above enumerated, we must classify these cases as idiopathic infections. In many instances the symptomatology is not characteristic either at the onset or during the course of the disease. Indeed, until there are definite localizing manifestations of suppuration in the iliac fossa (tenderness with mass formation) the picture may be easily confused with affections of the neighboring viscera or bony structures. The chief symptoms are the following:

Fever, at times of a low grade often extending over the course of weeks, at others intermittent with high elevations septic in type; chills and sweats of rather frequent occurrence. The presence of pain in the iliac fossa, the lower abdomen, or in the region of the groin, generally not severe in charac-



ter but more or less constant, was noted in every case. There is a gradual onset of psoas spasm, causing flexion of the thigh upon the abdomen and strongly simulating hip-joint disease. This spastic condition may be so marked that it is difficult (or even impossible) in spite of anæsthesia to straighten out the lower extremity. Increasing tenderness in the iliac fossa above Poupart's ligament, with rigidity of the abdominal muscles, develops. The appearance of a mass in the iliac region completes the clinical picture, and should make the diagnosis a certainty. It may not be manifest for weeks after the onset of the illness, but can eventually be demonstrated in almost every case, though at times the psoas spasm and rigidity of the abdominal walls make its delineation very difficult. Abdominal distention, frequently associated with the condition, may also make it difficult to palpate the mass. Rectal or vaginal examination will reveal tenderness and often induration or a swelling on the affected side of the pelvis.

Cases have been reported where suppuration had remained unrecognized until the abscess ruptured into the rectum, months after the onset. These abscesses have been known to burrow in all directions, dissecting their way through the various fascial planes and rupturing through the umbilicus, rectum or vagina, and even through the posterior abdominal wall. A leucocytosis varying from 12,000 to 20,000 white blood cells with a corresponding polymorphonuclear count is always found, but the urine shows no especially characteristic findings. Blood cultures were taken in only a few instances, and proved to be sterile, although cases have been reported in the literature with positive findings. Radiography of the pelvis and spine has in some cases been negative. In a few instances we observed haziness of the psoas outline on the affected side; and Laurell,<sup>1</sup> who has recently given us quite extensive and interesting observations on the radiographic symptoms of retroperitoneal suppuration reports frequent obscuration on this side. With this is associated a concavity of the spine towards the affected side, a phenomenon which had previously been described by Beer<sup>2</sup> and others as characteristic of perinephric suppuration. Due to spasm of the musculature on the involved side there is a thickening of the abdominal muscles in the flank, which shows up remarkably well in Laurell's röntgenograms. In addition to this, he considers as characteristic a network of dilated blood vessels in the subcutaneous tissues, due to the inhibited outflow from the veins in the abdominal wall, the result of pressure or thrombosis of the deeper veins. This is seen as a fine interlacing network of vessels on the film, in contrast to the absence of any such condition on the healthy side.

The diagnosis of retroperitoneal suppuration, as previously mentioned, may remain obscure for a long time. Cases have been reported where the condition was recognized only at autopsy. At other times the first clue as to the exact nature of the disease has been the rupturing of a large abscess through the bowel or vagina. In looking over our histories one is impressed with the slow course of some cases, which has rendered the diagnosis uncertain. A low grade temperature extending over weeks or even months,

with gradually increasing tenderness in the iliac fossa and flexion of the thigh, associated with rigidity of the abdominal wall, has in more than one instance been suggestive of Pott's disease or a hip-joint condition. Especially is this the case if the etiological factor has preceded the infection by sufficient time to lose sight of its relationship to the general picture. The diagnosis in children is more than usually difficult, especially in the absence of any apparent common cause. In the cases following puerperal infection, as reported by Huggins,<sup>3</sup> the differentiation of retroperitoneal suppuration from pelvic lymphangitis and thrombophlebitis may be most difficult.

Treatment, once the diagnosis has been definitely established, consists in wide incision and drainage. The importance of recognizing the true condition prior to operation is emphasized by the fact that in a few instances where such was not the case the abscess was opened into through the peritoneal cavity, with a sequence of peritonitis and death. We have in most instances employed either a para-rectus incision or one parallel to Poupart's ligament, reflecting the peritoneum mesially. At times the peritoneum has been found so fixed and indurated that this was accomplished with the utmost difficulty. The abscess cavity is then drained with soft rubber tubes (or preferably a rubber dam) and left wide open. Irrigation should not be attempted for at least one week, or until one is certain that the cavity is well walled off. Cultures of the pus have in most instances revealed the colon bacillus, streptococcus and staphylococcus aureus as the offending organisms.

The mortality rate in the definitely septic cases is by no means inconsiderable. Two patients in this series died following operation, a child ten months of age and a young woman of twenty-nine years who, following a miscarriage, developed retroperitoneal suppuration. Autopsy in this latter case disclosed, in addition, an extensive retroperitoneal cellulitis.

The following histories taken from our Service at Mount Sinai Hospital have been selected as illustrative of the condition:

CASE I.—A. R., male, twenty-nine years of age, was admitted to Mount Sinai Hospital December 20, 1928. The family and past histories were negative. The present illness had begun eleven days before admission, with severe pain in the lower portion of the left chest followed by chilly sensations, temperature between 102° and 104°, and a slight cough with scanty sputum.

Physical examination on admission showed the patient flushed and slightly cyanotic, the temperature 104°. There was some dyspnoea. The heart examination was negative, the blood pressure 95/65. The lungs showed crepitant râles at both bases, and röntgenogram of the chest revealed evidences of a bronchial pneumonia. There was slight tenderness over McBurney's point, but no mass was palpable. Rectal examination showed tenderness on the right side of the pelvis. The prostate was normal. Blood count: white blood cells, 23,600; polynuclears, 82 per cent.; hæmoglobin, 98 per cent.

The sputum was negative for tubercle bacilli and cultured "pneumococcus Type IV." Urinalysis was negative, but specimens showed pneumococcus Type I in cultures. A diagnosis of bronchopneumonia was made.

This patient continued to run a febrile course with a leucocytosis. On January 1,

1929, the spleen was palpable. The chest signs gradually improved, although a soft blowing systolic murmur became apparent over the apex. By January 11 all pulmonary signs had disappeared, although the temperature still persisted around 101°.

January 12, a little over three weeks following admission, the patient complained of some pain in the right iliac fossa. There was definite tenderness, but no rigidity. Rectal examination showed a fulness above the prostate, with tenderness on the right side. A note of the possibility of a pelvic abscess was made. On the following day there was psoas spasm, as evidenced by flexion of the right thigh on the abdomen. A mass was noted in the right iliac fossa, and the rectal mass became more pronounced. At this time the blood count showed: white blood cells, 13,600; polynuclears, 84 per cent.

*Operation.*—January 15. Oblique incision parallel to Poupart's ligament. On separating the muscles in the axis of the fibres, inflamed glands presented, lying on a dense inflammatory layer of tissue. These were perforated, and two ounces of thick pus evacuated. Tube drainage was instituted. The cultures of pus from the abscess cavity showed streptococcus Gamma.

Convalescence was uneventful, and the patient was discharged from the hospital February 5, 1929, three weeks after operation, in good condition.

CASE II.—R. G., female, twenty-seven years of age, was admitted to Mount Sinai Hospital October 3, 1925. The family history was negative. The past history included rheumatism at six years of age. Patient had been married ten years, had had two children and one miscarriage.

The present illness had begun five weeks ago, with coryza and fever lasting ten days. Four weeks previously sharp pain and soreness in the right lower quadrant of the abdomen, non-radiating in type and unassociated with vomiting, had developed and persisted. There had been several distinct chills, with a temperature of 105°. The pain, soreness and fever had continued up to the time first seen at the hospital. Patient complained of feeling weak and loss of weight. The vaginal discharge had become more profuse, thick and yellow; last period one month before admission. Patient stated that she had had a boil on the buttock incised after the onset of the present illness.

Physical examination showed a poorly nourished woman. The abdomen was soft except in the lower part, where there was some rigidity in both quadrants, with slight tenderness. Vaginal examination demonstrated a somewhat tender cystic mass about the size of an orange on the left side, more or less fixed. The right parametrium was thickened, the cervix lacerated. Smears from the cervix, vagina and urethra were negative for gonococci. The blood count showed the following: white blood cells, 11,200; polynuclears, 81 per cent.; hæmoglobin, 85 per cent. A diagnosis of right parametritis, with diseased left adnexa, was made.

October 13, ten days after admission, the white blood count rose to 14,600, and on the following day moderate pain in the right lower extremity developed.

October 25 the pain in the right lower quadrant of the abdomen became more marked, there was tenderness and resistance above Poupart's ligament; psoas spasm and flexion of the thigh on the abdomen developed.

November 1, the white blood count rose to 18,000; the hæmoglobin was still 85 per cent., as on admission.

Examination November 7 showed induration on the right side of the pelvis. There was no evidence of hip-joint disease and no spinal tenderness, although the psoas spasm was more marked and there was pronounced flexion of the thigh, attempts to extend it being very painful. The spasm could not be overcome by manipulation. A tentative diagnosis of chronic psoas spasm due to pelvic inflammation was made. On November 13 the motion of the lower spine in all directions was markedly limited and painful.

## SUPPURATIVE RETROPERITONEAL PELVIC LYMPHADENITIS

On December 7 the patient was seen in consultation by the Surgical Staff, and a diagnosis made of suppurative lymphadenitis of the retroperitoneal iliac glands, and operation advised. The urine at that time showed an occasional white blood cell; cultures were negative. The Wassermann test was negative, as were röntgenograms of the spine and pelvis.

*Operation.*—December 8, under gas, oxygen and ether. Under anæsthesia it was found impossible to overcome the psoas spasm and extend the thigh. Right rectus incision; peritoneum reflected mesially. An exudate was found overlying the iliac fascia. This fascia was incised, and beneath it and in between the muscles a broken-down material suggesting neoplastic tissue was evacuated. No evidence of any bony involvement could be found.

Following operation there was a profuse purulent discharge from the wound, which gradually subsided. The temperature returned to normal. The psoas spasm slowly disappeared, so that about three weeks afterward the thigh could be almost completely extended. The patient was discharged from the hospital January 21, 1926, able to walk without apparent discomfort.

The culture of pus obtained showed "streptococcus hæmolyticus." The specimen of tissue excised from the muscles overlying the ileum was reported "inflammatory exudate."

CASE III.—M. P., male, four years of age, was admitted to Mount Sinai Hospital June 2, 1927. The past history was negative except for measles. Twelve days previously the boy had fallen against a chair and struck the right side of his abdomen. He then developed, just prior to admission to the hospital, pain in the right lower quadrant with temperature between 100° and 102°.

Physical examination showed a well-nourished child. A small, tender mass could be palpated mesial to the anterior-superior spine. There was no rectus rigidity. Röntgenography of the pelvis was negative, as was rectal examination. The blood count was slightly elevated. A diagnosis of appendicular abscess was made.

*Operation.*—Through a right rectus incision a normal rectocæcal appendix was exposed. Along the lateral wall of the pelvis, lying extraperitoneally and to the outer side of the iliac vessels, a fluctuating mass the size of a plum was found. This was opened after the peritoneal cavity had been packed off, and the pus evacuated. The cultures were reported "streptococcus Beta."

This child made an uneventful recovery, and was discharged from the hospital July 7, 1927.

CASE IV.—J. S., female, four and one-half years of age, was admitted to Mount Sinai Hospital January 9, 1928. At the time of admission this young patient had a discharging ear, for which a mastoidectomy was performed.

Three days after operation she developed pain in the right hip region, with gradual flexion of the thigh upon the abdomen and elevation of temperature. Two weeks later a mass on the right side of the pelvis, over Poupart's ligament, was noted. Radiograms of the pelvis were negative.

*Operation.*—The abscess was opened and drained. Cultures of the pus from the ear had been reported "streptococcus Beta"; those from the retroperitoneal abscess showed an unidentified coccus in chains.

The child's convalescence was uneventful, and she was discharged from the hospital March 8, 1928.

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## OBSTETRICAL PARALYSIS\*

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EVER since the original publication of Duchenne and Erb, the term "obstetrical paralysis" (Erb's palsy, Erb-Duchenne paralysis, neuritis of brachial plexus) has come to be known as that condition affecting the upper extremity, and taking place at the time of delivery. There have been other cases described involving facial muscles and muscles of the lower extremity, but these cases are rare and have lately been classified under different headings.

The history of the condition dates back to the cases of compression paralysis reported by Smellie in 1768, in which the paralysis was encountered during a delivery with face presentation. Duchenne first described the condition in a logical way in 1872, but we have evidence of obstetrical paralysis in difficult deliveries as long ago as 200 years and it is quite probable that the condition has existed since forcible delivery was first employed.

Although Duchenne recognized three distinct forms, yet the type about which he wrote at length was that involving the upper extremity and designated by him as "laceration brachial birth palsy."

Two years later (1874), Erb published a case of this type, and as a result he has received much of the credit for the description of this lesion. In Erb's original paper he named as the causative factor "pressure in the axillary space, caused by the hooked finger as practiced by The Prague Method of eversion and forcible extraction." He apparently did not appreciate the inconsistency of a permanent palsy being induced in the fifth and sixth cervical nerve root distribution, by pressure in the axilla.

*Etiology.*—Since Erb and Duchenne published their articles, the weight of opinion has been directed toward the belief that obstetric paralysis is due to a stretching or partial tearing of the brachial plexus.

Taylor states that the condition may be caused by tension on the nerve trunks which first ruptures the nerve sheath and later tears the nerve fibres. In addition to rupturing the nerve sheath there is hæmorrhage into the nerve substance resulting in a hæmatogenous infiltration into the surrounding tissue. Following this, there is cicatricial contraction, and this in turn causes pressure upon the nerve, resulting in strangulation and preventing regeneration.

While nerve injuries may occur in all varieties of presentations, most authorities believe that the Duchenne-Erb type of palsy which involves the fifth and sixth cervical nerves is found almost exclusively after breech presentations.

T. Turner Thomas departs from the general opinion in his belief that obstetrical palsy is clearly due to some injury in the shoulder region.

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\* Read before the Philadelphia Academy of Surgery, January 7, 1930.

Weil, however, believes that the dislocation is to be regarded as the effect of paralysis, and not as its cause. No distortion of the shoulder joint can be demonstrated in the new bone. He believes that there is a great deal of palsy which, however, takes place *in utero*.

Sever states that the resulting paralysis is usually due either to forcible labor, a large baby, a small pelvis, anæsthesia, forceps, and generally a head delivery with the shoulder caught behind the pubis. With the last-named condition present, force applied so as to separate the head and shoulder will often result in brachial plexus injury.

The majority of cases of obstetrical paralysis occur in children of the lower classes, which means that they become cripples, and to a greater or less degree are a burden upon their parents and the community. If for no other reason than that these patients become parasitic to the community, there should be definite ideas established as to the etiology of the condition. It would seem to me that the condition can best be explained by a stretching or partial tearing of some of the branches of the brachial plexus (usually the fifth and sixth cervicals), with a secondary relaxation of the humeral capsule and the resulting deformities.

*Pathology.*—It is generally believed that the main pathological symptom, after paralysis has set in, is the presence of scar tissue in the vicinity of Erb's point, which is at the junction of the fifth and sixth cervical roots. In the acute form there may be a partial tearing or fraying out of some of the roots of the brachial plexus together with hæmorrhage under the sheath of the nerve which later goes on to clot formation, organization, and the formation of a cicatrix. Following this, there may be relaxation of the capsule and paralysis of certain groups of muscles. The suprascapular nerve is the one most commonly torn, and there is a fraying out at the junction of the fifth and sixth cervical nerves. There may be a fracture of the clavicle, the acromion process of the scapula, or a humeral fracture. In some cases there is a separation of the humeral epiphysis. There may be a dislocation of the shoulder, a temporary ischæmia of the nerve trunks, and, if the case is old, there may be osseous atrophy, and a shortening of the limb; there may be some stretching of the nerve fibres in milder cases, and in the more severe ones there may be actual rupture of large nerve trunks. The nerve sheaths may be injured, and there may be extravasation of blood into the sheath, or the blood may be widely spread out with subsequent inflammation.

*Symptoms.*—The three principal elementary deformities of a typical case of obstetric paralysis are (1) the internal rotation of the arm and forearm, (2) flexion at the elbow, and (3) the dangling of the extremity by the side. Internal rotation is impaired inasmuch as the extremity is held rotated inwardly as a part of the deformity. Passive movements with the exception of external rotation are free. In the typical position it is evident that this deformity is caused by the overaction of the unparalyzed muscles. Internal rotation of the arm is due to the action of the pectoralis major which more properly speaking adducts the arm and brings it forward over the chest.

The subscapularis rotates the arm inwardly and is assisted by the latissimus dorsi and the teres major. Pronation of the hand and forearm is partially caused by the internal rotation of the arm, but also by the inert or paralyzed supinator brevis and biceps muscles. Extension of the forearm on the arm results from a paralysis or weakness of the biceps, the brachialis anticus, the coracobrachialis and the supinator longus. In some old cases there is the inability to extend the forearm fully on the arm and is due sometimes to actual atrophy and malformation of the bones, or to a contraction of the capsule of the joint, especially the anterior portion. The reason for the extremity's hanging from the shoulder is due chiefly to the paralysis of the deltoid, and gravity keeps the extremity down.

The inability to rotate the arm externally is due to the paralysis of the infraspinatus and teres minor. The posterior portion of the deltoid helps in healthy arms to perform this movement.

The inability to supinate the forearm is due, in part, to the position of the arm and in part to weakness of the biceps and the supinator brevis.

As the paralysis continues, new conditions arise. On examination of the older cases we ordinarily find well-marked atrophy of the scapular muscles, sometimes a rotation of the scapula, or a standing off of its internal border from the ribs, which might be caused by weakness of the trapezius or of the serratus magnus. There is usually marked atrophy of the deltoid and some atrophy of the whole extremity, most apparent in the arm, somewhat in the forearm, while the intrinsic muscles of the hand are affected little or not at all.

Atrophy of the limb in the older cases is not confined solely to the muscles, but the bones themselves are affected and the whole limb may thus be smaller than the corresponding one. We may find at the shoulder a loose joint, though this is less extreme than in some cases of anterior poliomyelitis. I wish to call attention to the fact that the atrophy and paralysis of the arm muscles is less complete, as a rule, than in the old cases of anterior poliomyelitis. This may be due to the fact that in the laceration and ravelling of the nerve cords some fibres are left unharmed or are not totally destroyed.

It is quite common to find evidences of adhesions between the scapula and the structures around the shoulder joint, so that in partial passive elevation of the arm the scapula is moved, and as the arm becomes elevated above the level of the shoulder the scapula is drawn into the axilla. Inability to produce absolute extension of the forearm occurs in many cases. Passive supination of the forearm is sometimes impossible, apparently on account of adhesions.

Displacements of the head of the humerus are not rare. This usually is an anterior subluxation. It may, however, be displaced posteriorly. These displacements are due apparently to the contractions of the unparalyzed muscles and of the tissues surrounding the joint. There is no evidence of contraction of the paralyzed muscles.

The paralysis is almost always flaccid. The capsular ligament surround-

ing the joint is undoubtedly stretched. This comes as a result of complete paralysis of the spinati and deltoid muscles, leaving the posterior and external portions of the joint capsule without their usual muscular support. The glenoid cavity and the humeral head do not develop so rapidly as they should and thus favor dislocation. As the pectoralis major, which is usually only partly paralyzed, rotates the arm inwardly, it exerts fairly strong backward pressure, and this action is abetted by the subscapularis, teres major, and latissimus dorsi when these last-named muscles partially escape paralysis. The cause of the posterior subluxation is more doubtful. The paralysis of the supraspinatus is undoubtedly the most important factor. The contraction of the latissimus dorsi and the sternocostal portion of the pectoralis major tend to separate the head of the humerus from its socket, and if unopposed may cause subluxation. They are opposed by the coracobrachialis and the long head of the triceps.

Usually extension of the forearm on the arm is impaired. Full extension, either active or passive, is not possible, resistance being encountered toward the end of the extension. The forearm remains at an obtuse angle of 170 or 175 degrees with the arm. This may often be due to the contraction of ligaments or of the tissues surrounding the joints, but is at times due to atrophy and malformations of the bones themselves.

In the Duchenne-Erb or upper-arm type, the upper part of the plexus is affected. Damage involves the fifth and sixth cervical roots and there is a loss of power in the muscles about the scapula and arm.

Involvement of the eighth cervical and first thoracic results in a type of paralysis usually known as Klumpke's or forearm type. Loss of function and power occurs in the muscles of the hand and of the large flexor muscles of the forearm. The second thoracic root is sometimes involved, resulting in a paralysis of the muscles supplied by the musculospiral nerve which includes the extensors of the hand and fingers.

When there is more or less complete damage of the plexus, there is a resulting loss of power in both the arm and forearm. It is possible for this condition to be caused by a posterior subluxation of the humeral head.

In certain other cases there may be combinations of the several forms with a partial or total paralysis. In isolated cases, one muscle, such as the deltoid or supinator longus, may alone be involved. Damage involving both upper extremities is extremely rare.

When cases are seen early by the physician and if the paralyses are in conjunction with some fracture of the shoulder girdle, there is often sensitiveness to pressure and evident pain on motion of the arm. When the cases are seen during the latter part of the first year of their duration we have accommodation of contraction of muscles and a limitation of motion. In cases seen late, there is often fixed inward rotation with a subluxation of the humeral head.

The X-ray findings, as a rule, run fairly true to form. During the first year there is very little, if any, bone deformity. Following this period the



epiphysis as well as the shaft of the humerus is smaller than the unaffected side. This in all probability is caused by disuse atrophy. The scapula is practically always elevated. As time goes on there is an increased amount of subluxation of the shoulder-joint and there is a developing deformity of the acromion process which consists of a hooking down of its outer end, due, no doubt, to the fact that there is no resistance in the form of a humeral head. Scoliosis may be present and when there have been fractures there will be X-ray evidence of this. The clavicle is usually shorter and its curves more acute than normally.

*Diagnosis.*—Diagnosis is not difficult if the patient has been seen early. There is usually a history of a long, difficult labor, with a disproportion between the child and the birth outlet. There is usually some instrumentation or forceful manipulation in an attempt to extract the baby. After the birth of the child, manipulation of the shoulder usually causes the child to cry out with pain, the extremity hangs limp at the side, and soon becomes internally rotated. Paralysis is of the flaccid type and there is a diminution of reaction to electrical stimulation.

*Differential Diagnosis.*—*A.* A patient with obstetric paralysis seen late in the disease after he is over a year old may be readily confounded with a similar condition existing after poliomyelitis. Both diseases have atrophic paralysis of a flaccid type. The history of the case, however, will lead to a correct diagnosis, inasmuch as the age of onset is different, and the degree of wasting and the characteristic localization of the involvement readily distinguish a case of obstetric palsy.

*B.* We must also distinguish this condition from a spastic cerebral palsy and in very young infants this is extremely difficult. In a spastic case the attitude of the arm is the same as in the upper-arm type of obstetric palsy because the adductors and inward rotators of the humerus and the pronators of the forearm are naturally the stronger. The diagnosis may be arrived at if there is spasticity and lack of voluntary use of the lower extremity on the same side as the arm palsy unless the cerebral palsy has involved the arm only, which is extremely rare.

*C.* We must determine whether or not there has been a congenital luxation or subluxation or injury to the capsule of the shoulder during birth.

*D.* There may be present a traumatic effusion which in turn may cause a luxation or subluxation of the shoulder-joint.

*E.* Separation of the epiphysis may be diagnosed by X-ray.

*Prophylaxis.*—Prophylaxis must of necessity consist of periodic warnings to the profession emphasizing the difficulties with which we must cope and for which we must be constantly alert. True enough, in long, hard labors we are sometimes only too glad to be able to deliver the child and to save the mother, and practically any manipulation that will bring about this end is justifiable. We should try to avoid the pulling, stretching, and tearing of the nerve roots, namely the fifth and sixth cervicals which are most

likely to be put on tension by these obstetrical maneuvers, so that we can at least be making a constructive effort to avoid the production of this deformity.

*Prognosis.*—The prognosis varies in direct ratio to the time the disease has been going on, and to the extent of the involvement. In the more extensive cases the prognosis is extremely grave. If the nerves have simply been stretched or frayed out a little, complete or nearly complete repair and restoration of function is usually possible. If the nerve trunks, however, have been much frayed out or ruptured, and hæmorrhage has occurred between the ends, there will be retraction of the nerve fibres and formation of much cicatricial tissue. In these cases there is retardation of growth together with shortening of the tissues and very little, if any, return of function. Complete spontaneous recovery is rare and occurs only in very mild cases. If recovery is to be complete, it usually occurs at the end of three months, and almost never later than six months. In the great majority of cases there will be some permanent defect. Unless these cases are treated intelligently and early we must expect discouraging results.

*Treatment.*—As to treatment, the upper-arm type can, if seen early, be treated with support, massage and exercises. Those of the lower-arm type usually come to operation, which is usually a repair to the plexus. If the upper-arm type comes late for treatment, one has also to operate and correct contraction deformities. Even in the lower-arm type one may try conservative treatment and if there is no benefit one may then resort to operation. In order to prevent contraction of the paralyzed muscles, it seems best to put the arm at rest in such a position that the stronger muscles cannot contract. This may be done by means of a plaster case or a wire splint. The arm should be abducted to a right angle with the torso (90 degrees) or perhaps a little elevated so as to approximate the injured nerve. The limb should be rotated outward 90 degrees and the forearm supinated with the elbow flexed. Where subluxation or fracture exists it should be reduced. If contractions at the shoulder exist one may first try manipulation under anæsthesia.

The so-called standard treatment of Sever has been used with success for some time and on the whole is a very satisfactory procedure.

The treatment of these cases then resolves itself into those which lend themselves to massage, exercise and manipulation, usually of the upper-arm type, and those coming to operation. Unless the upper-arm type comes to early treatment it may also come to operation.

There has been no case yet, reported to my knowledge, which has shown an anatomic and physiologic cure from the plexus operation. Even marked improvement is usually lacking. This may in part be due to the fact that the deformities were not first recognized and corrected and the plexus operation done later. Many times the nerve is so badly damaged that it is beyond repair.

In a small series of cases I have employed a simple osteotomy of the humerus to correct the inward rotation at the shoulder. The operation is

done as follows: With the patient lying on his back on the operating table and the arm across his chest, an incision is made down the anterior aspect of the arm in its lower third. This incision is made so as to get sufficient exposure. Routine intermuscular dissection is done down to the bone. The periosteum is carefully dissected back and preserved. By means of an osteotome the humerus is completely cut through. Great care must be exercised in this procedure so as not to displace the relationship of the fragments. The arm is then gently rotated for 30 degrees outwardly and after routine closure a plaster-of-Paris spica case applied to the shoulder and extremity, holding the arm in the position of abduction, external rotation, and supination of the flexed forearm. This case is allowed to remain on until there is firm union, after which it is removed and a wire splint substituted, and massage and exercise begun. Exercise should be kept up for a year after operation and longer if benefit is still being derived. The results of the operation are a normal carrying angle of the arm with the elbow at the side and a normal position of the hand. It is possible to bring the hand to the head and even back of the head. It is possible to bring the hand back of the waist and in many cases, it is difficult to tell which is the operated side.

#### CONCLUSIONS

1. Obstetrical paralysis should be treated as an orthopædic condition and all deformities carefully observed and prevented.
2. The shoulder should be put in plaster at once, holding it in 90 degrees' abduction, 90 degrees' external rotation and with the forearm flexed and supinated.
3. In most cases the injuries to the nerves are not severe and if treated early will tend to recover.
4. Relaxation and dislocation of the shoulder are secondary lesions.
5. When the deformity of internal rotation and hyperextension of the elbow exists a rotation osteotomy is advisable and usually suffices to give function.
6. A patient suffering from obstetrical paralysis should be under observation until the age of ten for fear of a persistence of slight deformity.

# OPERATIVE TREATMENT OF COMPRESSION FRACTURES OF THE CALCANEUS

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THE prognosis of os calcis fractures is very bad as patients are not able to walk without pain for a long time. This is owing to the fact that, contrary to the general principles of the treatment of fractures, reduction in this type of fractures is not effected. The current methods of treatment aim only at the correction of the deformity of the heel and wholly neglect the subastragaloid joint. We must remember that in these fractures the so-called "thalamus" \* is crushed into the spongiosa of the calcaneus and, what is still worse, its anterior border is pushed downward, so that the foot is twisted toward a valgus position. The equilibrium of the subastragaloid joint is disturbed; the traumatic arthritis which develops is the main cause of persisting pain and disability; as a matter of fact patients are not able to walk with comfort before subastragaloid ankylosis has set in.

It is therefore necessary in order to better the prognosis of these fractures to exercise a direct action on the depressed and tilted thalamus, to reestablish its normal articular relations with the talus and make this permanent by fixation. In doing this, we only follow in a particular case the general rules regulating the treatment of joint fractures in the lower extremity. According to Professeur Leriche, by surgical treatment only can this be realized.

Professeur Leriche was the first (1921) to apply this method <sup>1</sup> which has grown to be quite a routine operation in his clinic.

The following case reports will show the results obtained.

CASE I.—A., Jean, forty-two years old, a trade man, jumped out of a window from the first story of his burning house March 3, 1925. He fell standing on his feet and immediately felt an acute pain in his right heel. After examination at the clinic we diagnosed a compression fracture of the calcaneus. At X-ray picture (Fig. 1) the thalamus was slightly forced in; three principal cracks were found that presented a Y-shape, isolating partially the tuber calcanei and the greater process. Antero-posterior view showed prominent multiple fragments under the malleolus externus.

This patient was subjected to operation March 5, 1925, by Professeur Leriche under spinal analgesia. External submalleolar incision. After section of the lateral peronei tendons the focus was discovered. A big fragment divided by a Y-shaped crack was separated from the rest of the bone. It represented the biggest part of the external face and also the posterior portion of the posterior articular surface of the calcaneus. After cleaning of the focus and extirpation of multiple small spongy fragments the principal fragments were put back in place. The articular edge was reconstituted and the whole

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\* We call "thalamus" the thickest portion of the superior calcaneal cortex supporting the facies articularis posterior.

fixed with an "agrafe de Dujarier." Tendons and skin were stitched. The limb was immobilized in a gutter case.

The post-operative course was normal. The case was taken off April 17, 1925. Patient was allowed to go home, but not to walk.

Four weeks later he could walk with two sticks; he was still suffering a little and could not entirely put his weight on his heel. He was still carrying a very small fistula. Then a new X-ray picture showed a slight osteoporosis of the calcaneus; the fracture lines were not seen any longer. The "Dujarier agrafe" was still at the same place, but there existed around its points small areas of decalcification.

May 20 it was removed under local anæsthesia. Five months after the accident the patient could walk without any pain. When walking on uneven ground he still felt some functional disturbances and slight pain. At night there was some swelling of the foot. The fistula persisted at the level of the scar. The subastragaloid joint was already blocked.

June, 1926, the patient was examined again. A little fistula was still present. The patient could walk and work just as before his accident. A new X-ray picture showed



FIG. 1.—Case I. A., March 4, 1925.

that the calcaneus was lessened in height, but had a distinct trabecular system. The posterior subastragaloid joint was ankylosed; a few osteophytes could be seen behind it. A little sequestrum contained in a small cavity marked the place of the removed clip. As he was feeling quite well, the patient did not agree to further operation. The slight swelling had disappeared and there was no muscular atrophy.

October, 1926, at the patient's request, the little sequestrum was removed. January, 1927, patient was walking without any

discomfort. He received no compensation fee. Footprints showed no heel enlargement and no flat foot.

CASE II.—W., Anna, eighteen years old, factory hand, on account of a fire, March 3, 1925, jumped into the street from the first story of her house. She fell on her feet, got up, but could not walk, perceiving an acute pain in her right foot which swelled up immediately. The patient was brought to the clinic. Examination revealed a large hæmatoma deforming the region of the heel. Movements were impossible. The X-ray picture showed a compression fracture of the calcaneus (Fig. 2). Lateral view showed multiple fracture lines, and among them there was one which reached the calcaneo-cuboidal joint. The tuber calcanei was almost separated from the corpus by a vertical incomplete crack. Front view showed multiple fragments under the fibular malleolus.

Two days later, on the fifth of March, the patient was operated on by Doctor Stulz under spinal analgesia. The surgeon reached the calcaneus by an external submalleolar incision. The tendons of the peronei were cut. Multiple fragments were found coming from the external compacta. One of them, found in front, bigger than the others, included the external portion of the calcaneo-cuboidal articular surface. Another, upper one, included the outer half of the posterior astragalo-calcaneal articular surface. In short the calcaneus seemed to be divided into three parts by a Y-shaped fracture line. The inner half of the posterior articular surface was still in contact with the talus and penetrated with the latter into the spongiosa of the os calcis. The crushed fragment was raised and the divided articular surface was reconstituted and screwed. An "agrafe de Dujarier" kept together the two portions of the greater process. This agrafe could not be firmly fixed in the spongy tissue. The tendons and skin were stitched and a gutter plaster case applied.

## COMPRESSION FRACTURES OF CALCANEUS

April 3, 1925: After a normal post-operative course the first case was taken off. The wound had healed per primam. A new case was put on.

April 30: The second case was removed. The foot seemed normal without broadening in its osierior part. Mobilization and massage were prescribed.

May 15: The patient got up. She could put her weight on her left foot without feeling any pain. The tibiotarsal joint very quickly recovered all its movements. The subastragaloid joint was slightly stiffened and painful on motion.

June 11: The patient could walk, go up and down stairs easily. Still there was a little muscular atrophy in the left leg and thigh. No more swelling at night. The foot presented a normal aspect. The patient could go back home with an ordinary foot pad in her left shoe. In December, 1925, we heard from the patient that she could walk without any trouble. In November, 1926, the patient was working in Paris as a chambermaid. Skiagraphs now taken showed an almost complete disappearance of the subastragaloid interline (Fig. 3). We could hardly guess the fracture lines. Trabecular system of the calcaneus was found nearly normal both in constitution and direction. The screw was well tolerated, there was no important rarefaction around it. The calcaneus was not broadened. Since then we have not heard of her.



FIG. 2.—Case II. W., March 5, 1925.



FIG. 3.—Case II. W., November, 1926.

CASE III.—Z., André, fifty-four years old, clerk, December 30, 1926, fell down an elevator shaft from a height of 4 metres. He fell on his heels and felt immediately an acute pain in his right foot which began to swell. He was taken to the surgical clinic where the diagnosis of crushing fracture of the calcaneus was made. The X-ray picture showed a penetration of the thalamus with fracture of the greater process. A fracture line, shaped like a horizontal Y, divided the latter into two parts: an upper one retaining its normal position; the lower one was lightly tilted back and downward in such a way that its posterior portion was pushed toward the sole. Was immobilized in a plaster case.

January 11, 1927, Professeur Leriche operated under spinal analgesia. External submalleolar incision, section of lateral peronei tendons. Exposure of the calcaneus. The thalamus supporting the astragalus was found penetrating into the body of the bone. The thalamus is lifted and fixed in normal position to the calcaneus and the astragalus by two "agrafes de Dujarier." Articular surfaces were not abraded. A gauze drain was left in the anterior part of the wound on account of blood leaking from the everted spongy tissue. Gutter plaster case. Normal post-operative course. January 31: Dressing; new case applied.

February 15: The case and drain were taken off. Dressing. X-ray. The patient was allowed to practise foot movements.

He got up on March 2 and walked without pain. The foot was flat and in light valgus (so was the other foot, but in a lesser degree). Subastragaloid joint was blocked, tibiotarsal limited but painless. Large œdema at night. Nothing special in the scar. No muscular atrophy of the thigh.

March 28, 1927, under spinal analgesia both agrafes were removed. Astragalus and calcaneus were united and made but one bone.

April 15, patient left with his wound completely healed. He was still helping himself along with a stick but could lean on his foot without pain in spite of his weight (98 kilos'). The œdema after standing had become less pronounced.

August 8, 1927, greatly improved; he had gone back to work June 27 and was receiving half pay. He could walk without a stick, but was limping lightly, avoiding leaning too hardly on his injured foot. At the end of a day's work he still felt pain in the back part of the foot which was in valgus. At night he had œdema up to the middle of his calf. The subastragaloid joint was blocked, tibiotarsal was free. Incapacity rate yet 50 per cent.

Patient reported November 25, 1927. He was working regularly and receiving his former salary. He was still feeling a few pains in the back of the foot, and the scar. His limp had disappeared. Œdema had much lessened. The retromalleolar gutters were still filled. Pressure revealed a tender area on the scar level under the external malleolus. Incapacity was rated at 10 per cent.

CASE IV.—J., August, forty-four years old, farmer, July 9, 1927, fell down a stair. He struck the floor on his heels and at once complained of an acute pain in the back of the left foot. Unable to stand up, he was carried to the clinic, where a compression fracture of the calcaneus was diagnosed. X-ray picture showed a depression of the thalamus with a fissure slanting down and backward and ending before the calcaneal spur.

After a few days' rest he was operated on by Professeur Leriche July 16, 1927. Exposure of the calcaneus by the same procedure as before. The lesions of the external portion of the calcaneus were much more considerable than the X-rays had revealed. There were three fragments, one being almost entirely free and aiming at the astragalocalcaneal interline. They were fixed with two screws, and an "agrafe," inserted in the calcaneus and in the external malleolus, kept the external fragment in its normal place. Sutures and plaster gutter case.

Normal post-operative course. Case was taken off August 28. After fifteen days' rest in bed, the patient was allowed to get up and walk with a small tube case, after which he walked without pain. October 18 case was removed and so were, a few days later, clip and screws.

After healing, the patient got up again. He walked easily with a stick, feeling only very slight pain in the back of the foot under the external malleolus. There was a light valgus of the foot and a noticeable œdema reaching the middle of the leg. The subastragalar joint movements were blocked; those of the tibiotarsal were reduced to two-thirds of the normal excursion. X-ray showed a complete fusion of astragalus and calcaneus in the subastragalar interline.

We have heard lately that this man was examined November 9 by an expert in order to determine his incapacity rate. The patient could walk easily, without limping. The retromalleolar gutters were still filled. Tibiotarsal joint was nearly normal, but subastragalar joint was ankylosed. The expert estimated to 20 per cent. the incapacity rate and advised a new examination nine or ten months later.

CASE V.—F., Charles, forty-three years, mason, November 24, 1928, fell down from a three-metre-high ladder. Fracture of the left calcaneus resulted. X-ray showed a depression of the thalamus with a bursting of the external calcaneal cortex.

Doctor Simon, November 25, under spinal analgesia, made a curvilinear incision behind and under the external malleolus. After section of the peroneal tendons he exposed the focus. The external cortex was split into many fragments. The bone tissue was completely crushed, the thalamus, forced into the spongy tissue, was tilted in such a way that its articular surface was in direct connection with the greater process. Once lifted, it could be kept in correct position only by an "agrafe de Dujarier" fixed in the thalamus

## COMPRESSION FRACTURES OF CALCANEUS

and in the greater process. Sutures of tendons and teguments. Posterior plaster splint.

Normal post-operative course. A month later the case and the stitches were taken off. The patient was kept in bed, although he was allowed to start mobilization of the foot joints. An X-ray taken December 31, 1928, showed perfect reconstitution of the articular thalamus surface. No osteoporosis at the clip level.

January 30, 1929, under local, the "agrafe" was removed and the patient allowed to get up after complete healing of the wound. Since then, he was able to walk without pain with a stick. He left the clinic February 15.

Reported March 9: he was walking easily, but yet with a stick and complaining of little pain in his heel after a lengthened walk. The foot was in good position without valgus. No œdema; only a slight thickening at the level of the external retromalleolar region. Nothing particular about the scar; the calcaneus was a little broadened and tender at pressure. Movements of the subastragalar joint were blocked. One month later the patient went back to work.

CASE VI.—Mr. O. fractured his right calcaneus November 17, 1929, by falling down a stair. An X-ray showed a tilted thalamus with a fracture of the greater process and a planter fragment. He was operated on by Doctor Stulz November 18. Technic as

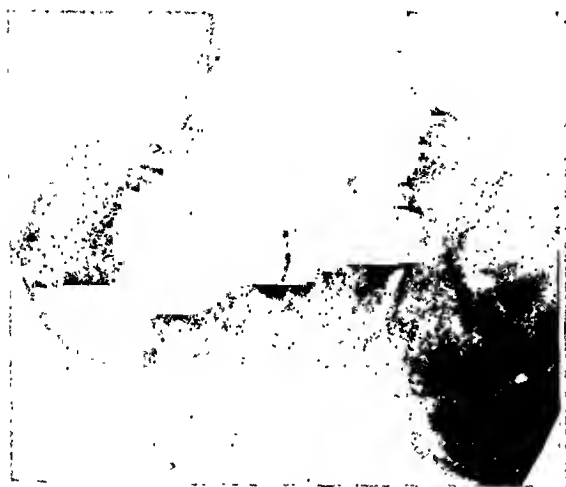


FIG. 4.—Case VI. Mr. O. before operation.

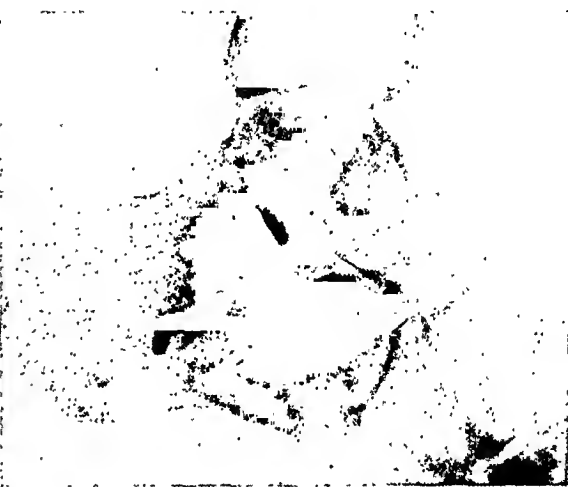


FIG. 5.—Case VI. Mr. O. after operation.

above. Reduction of displacements and fixation in correct position by an agrafe. X-ray proved that reduction was perfect and the normal shape obtained. Normal post-operative course.

Final result is not yet definite, but we publish the case since the X-ray pictures are quite typical. (Figs. 4 and 5.)

The results of the operations done in these cases have been satisfactory. The duration of pains and total disability has been notably reduced. But it should be mentioned that, as in the first two cases operated by Professeur Leriche,\* an ankylosis of the posterior astragalo-calcanean joint has followed. Therefore, one might ask, why not at once secure an ankylosis by carrying out an arthrodesis, as has been suggested? Because, first of all, ankylosis might not supervene, and moreover, because the ankylosis following arthrodesis without reduction of the thalamus is an ankylosis in bad position as compared with that following reduction of the depressed articular fragment. Finally, because the open reduction and fixation present no particular difficulty.

\* One of these cases has been recently reexamined by Professeur Leriche. Seven years after operation the result was excellent.



Nevertheless, there are certain cases in which the damage to the joint is too great to allow of proper repair and there are others in which one cannot replace the thalamus.

We have treated one such case in which we were obliged to carry out an arthrodesis.

CASE VII.—R., Paul, eighteen years old, had his right foot crushed, September 19, 1926, by a heavy iron beam, just under the internal malleolus. Brought immediately to the hospital where a fracture of the calcaneus was diagnosed. It was a crushing fracture. The posterior portion of the astragalus had penetrated into the calcaneus, forcing the thalamus into the spongy tissue. The greater process was separated by an oblique line, a large plantar fragment was prominent at the inferior side of the bone and a few splinters projected under the external malleolus.

After five days of immobilization, the patient was operated on by Doctor Simon. Transversal 8-centimetres-incision, about 1 inch under the external malleolus, section of the peroneal tendons, denudation of the external face of the calcaneus, esquillectomy. The fracture line that loosened the greater process was seen clearly. The subthlamic region was all crushed. As the thalamus could not be replaced, an arthrodesis was decided upon. The astragalo-calcaneal joint cartilage was abraded with a thin chisel. The plantar fragment could not be reached by this incision and was left in place. Wound was closed in the usual manner and a gutter case put on.

Normal post-operative course. The case was taken off eleven weeks later and the patient remained in bed three weeks more, mobilizing softly his foot and his knee. After that he got up and walked immediately with the simple help of a stick.

January 20, 1927, he could walk alone without feeling any pain, but was slightly limping on his injured foot which was very much swollen at the end of the day and lightly deviated in valgus. There existed a permanent widening of its posterior third, the normal internal submalleolar depression could not be noticed; the tibiotarsal joint was free, subastragalar joint was blocked. Plantar prints were the same on both sides. There was no muscular atrophy of the leg but the right thigh was 2 centimetres smaller in circumference than the left one. The X-ray showed a diffuse rarefaction of the tarsus; the fracture lines had disappeared. The subastragalar articular interline presented a horizontal direction. It was almost entirely obliterated.

March 20, 1927, the condition of the patient had considerably improved. Evening swelling had reduced; walking was easy and painless.

July 11, 1927, the patient was examined by an expert who estimated the incapacity rate at 25 per cent. The same expert re-examined the patient October 19, 1928, and on account of a great improvement in his condition, reduced this rate to 10 per cent.

The subastragaloid arthrodesis appears to us to be altogether preferable to primary astragalectomy, as advised in France by Soubeyrand and Rives.<sup>2</sup> Nevertheless, the latter operation is indicated in fractures with complete comminution of the bone when it is impossible to reconstitute the articular surfaces or to do an arthrodesis.

This indication was strictly given in the following case:

CASE VIII.—H., Emile, thirty-nine years old, was brought to the clinic October 28, 1926. He had fallen onto his heels into a very deep hole.

X-ray showed a crushing fracture of the calcaneus; fracture lines could not be clearly distinguished. The posterior part of the astragalus was strongly forced into the calcaneus. The posterior and the inferior outlines of the bone seemed normal (Fig. 6).

November 1 Professeur Leriche found a crushing fracture with multiple fragments. The anterior part of the calcaneus entirely crushed. The astragalus was projected for-

ward head up. Straightening was made impossible by the bursting condition of the anterior articular surface and the outside projection of two fragments. Astragalectomy was performed and the calcaneal surface mended as well as possible. Extirpation of small external fragments; gauze drain; closure of the wound; gutter case.

The patient was kept under observation for a few days and November 23 went home. A new case was put on on December 15, taken off on February 5, 1927, then he began to walk. He reported on March 15, 1927. The foot and the inferior third of the leg were very much swollen. The movements of the ankle had an amplitude of twenty degrees. The patient walked without pain but was in need of two sticks. June 21, 1927, the patient still walked with his sticks and could hardly put his weight on his foot. The œdema had lessened and was localized to the posterior part of the foot and the inferior half of the leg. The new ankle was stiff. The patient was seen again November 19, 1927. He was not suffering any more but still limping and walking with a stick. Slight evening swelling persisted. June 19, 1928, he complained of quick fatigue and slight pain in his foot after a lengthened walk. A trifling œdema of the foot and the inferior third of the leg was still present. Pressure revealed pain in the tibio-calcaneal interline. The foot could scarcely be moved in this interline. Unshod, walking was difficult, but satisfactory with an orthopœdic shoe. The stick was superfluous. The working incapacity was rated at 25 per cent.



FIG. 6.—Case VIII. II., October 28, 1926.

In conclusion we might summarize the lines of treatment of compression fractures of the calcaneus as follows: These fractures must be operated systematically. One is concerned primarily with the correct apposition of the articular surfaces of the astragalo-calcaneal joint. To

secure this, the thalamus must be lifted, the articular surface repaired and fixed in proper position. Second in importance is the reduction and fixation of the other fragments of the calcaneus. If reduction appears impossible, we must have recourse to a subastragaloid arthrodesis. Finally in certain exceptional cases one is driven to effect astragalectomy.

This surgical treatment has been used more or less accurately by other surgeons.

Nové-Josserand,<sup>3</sup> Cotte,<sup>4</sup> Valls<sup>5</sup> have achieved as well as we have most satisfactory results.

We do not insist on the technic of reduction and osteosynthesis. The particulars of the technic vary according to the lesions met with which are often more severe than X-ray pictures would lead to believe. The horizontal external submalleolar incision gives a sufficiently good access. In raising the thalamus, one must avoid using the inferior part of the calcaneus as a fulcrum since strong pressure might damage the hitherto intact bone.

The means of fixation are sometimes screws, sometimes clips like "agrafes de Dujarier," sometimes screwed-in plates. It seems to us advisable in cases in which a cavity persists under the reduced thalamus to fill this cavity with several osteo-periosteal grafts<sup>6</sup>; this procedure would facilitate consolidation

and thus avoid the long period of osteoporosis which in every instance follows the fractures of the calcaneus.

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- <sup>2</sup> Soubeyrand et Rives. Rev. de Chir., t. xlvii, 1913, pp. 429-473.
- <sup>3</sup> Lyon Chirurgical, 1928, t. xxv, p. 217, Soc. de Chir. de Lyon, 1 décembre 1927.
- <sup>4</sup> Lyon Chirurgical, t. xxvi, p. 115, Soc. de Chir. de Lyon 22 novembre 1928.
- <sup>5</sup> La Prensa Medica Argentina, el. 10 de Enero de 1929.
- <sup>6</sup> M. Lenormant has, without troubling about the subastragaloid joint, performed this operation a few times; he assigns to these grafts the part of holding up and keeping in place the thalamus after having reduced it first. Bibl.: Bull. & Mém. Soc. Nat. de Chir., Paris, t. liv, pp. 1353-1356.

# THE MANAGEMENT OF FRACTURE OF THE FEMUR

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NO PROBLEM in skeletal surgery has held the medical attention in this first post-war decade more than the treatment of fractures of the femur. In spite of extensive experiences during and following the war, fractures of this bone still remain the most difficult to manage, the most productive of deformity, and the most likely to cause fatalities. The surgical profession is agreed that in all cases of fracture of the femur with overriding, traction of some kind is indicated, yet it is by no means united in its opinions with regard to a standardized form of management or operative methods to be employed; and this diversity of opinion is present not only in the profession in general, but even among men specially trained in handling problems of skeletal injuries. This same lack of standardization obtains with regard to evaluating end-results, causing confusion when one reads reports of end-results expressed in such elastic terms, as fair, good, or perfect.

It follows, therefore, that any attempt at standardization must progress along the path of uniformity of classification (nomenclature), treatment (management), and grading (evaluation of end-results). The easiest way often is the best, and any method that eliminates overmanagement and institutes economy in manipulation eventually becomes the accepted standard. War and post-war experiences have definitely proven that in frankly displaced and overriding fracture of the femur, direct skeletal traction gave uniformly good results.

In 1919, the writer—collaborating with Dr. John J. Moorhead\*—made a study of the relative effectiveness of the different types of skeletal traction in overlapped fractures of the femur, in the wards of the Harlem Hospital, and conclusively proved to himself that with the type of patient encountered in a city hospital where often the coöperation by the patient was poor or none at all, transfixion with a Steinman nail gave, by far, the most satisfactory results. Since then, at the New York Post-Graduate Hospital and in private practice, this has been used where traction was indicated.

The following is a report of a consecutive series of 100 unselected cases treated in a uniform method at the New York Post-Graduate Hospital, and follows out the attempted standardization proposed above:

*Classification.*—For practical purposes, fractures of the femur, as well as fractures in general, can be divided into two main types, based on the presence or absence of displacement of the fragments. Either may be simple

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\* Surgery, Gynecology and Obstetrics, September, 1920.

or compound. This grouping disregards any differences, such as comminution, direction of fracture line, level of lesion, or the mode of injury.

*Group 1.*—Comprises the displaced, separated or mal-aligned type in which the fragments are not end to end, but are overlapped in their vertical or lateral axes, and in which reduction is necessary.

*Group 2.*—Comprises the non-displaced, non-separated, or aligned type,



FIG 1—Fracture of femur Malunion four months old 3 inch shortening

FIG 2—Appearance after oblique osteotomy and introduction of nail traction

in which the fragments are end to end, and not overlapped, and in which reduction is unnecessary.

Thus grouped, or “typed,” we convey to the mind differences in amount or quantity rather than actual variety of “fracture,” and the pathology of the existing original condition conveys the amount, rather than the variety, of treatment to be instituted.

Further classification follows the anatomical location of the trauma, giv-

ing a qualitative determination, and gives three zones of incidence—those at either articular end of the bone, and those of the shaft. The former are by far most crippling—those of the neck of the femur because of the age and physique of the patient, and those near the condyles because of the difficulty of obtaining and maintaining adequate reduction and the associated injuries occurring in the knee-joint. In considering any classification, we must bear in mind that the basic pathology in fractures is a lacerated wound of bone and attached periosteum, with associated lesions of the soft parts (myositis and teno-synovitis), joints (synovitis, arthritis and bursitis), and vessels (vascular and neural), and that the deformity is produced and maintained by the muscular spasm, and that in setting a fracture, we actually set the muscles, obtaining proper coaptation and alignment of the bone only after the muscular spasm has been overcome.

Thus, quantitatively classified, our series gave the following number of cases: Type 1 (displaced) 54; Type 2 (non-displaced) 46.

Anatomically or qualitatively classified, these cases showed the following varieties:

*Upper articular end of bone:*

Neck of femur	14	} Females 9—Males 5
Trochanteric	4	
Sub-trochanteric	3	

*Shaft of femur:*

Upper third of shaft	24	} Females 17 and Males 52
Middle third of shaft	28	
Lower third of shaft	17	

*Lower articular end of bone:*

Supracondylar	9	} Females 1 Males 9
Condylar	1	

The greatest zones of incidence are the neck and shaft, and gave 14 per cent. and 69 per cent., respectively, of the total number of cases. The right femur was involved in 55 per cent, the left in 39 per cent, and bilateral 6 per cent.

The age incidence was as follows: First decade, 22 per cent.; second decade, 19 per cent.; third decade, 12 per cent.; fourth decade, 15 per cent.; fifth decade, 14 per cent.; sixth decade or over, 18 per cent.

There were 64 males, 36 females, and 24 children. The youngest case was nine months, the oldest ninety-two years. The oldest neck of femur case was ninety-two years, the youngest forty-one years.

Duration of the fracture on admission: One day, 29 per cent.; three days, 26 per cent.; one week, 10 per cent.; two weeks, 6 per cent.; one month, 15 per cent.; three months, 7 per cent.; six months or more, 7 per cent.

Associated lesions present were as follows: Both femurs, 8 cases; one femur with tibia and fibula, 4 cases; one femur with patella, 1 case; one femur with pelvis, 1 case; one femur with surgical neck of humerus, 1 case.

*Treatment.*—Before approaching the problems of treatment, several cardinal considerations present themselves for our attention, as follows:

1. *Time of Reduction.*—This is of prime importance, as early reduction means more accurate and easier reduction; and preliminary traction, irrespective of subsequent treatment, is of great aid toward this end. The presence of swelling is no contraindication to reduction.

2. *Correct Coaptation.*—This leads to a minimum amount of callus, for



FIG 3—Lateral view with nail traction in situ

FIG 4—Appearance four weeks after removal of nail traction

a lacerated bone, like any other laceration, will heal by primary union if the edges are well approximated; whereas non-approximation will lead to secondary union and excessive callus.

3. *Compound Fractures.*—Experience has taught us that we can convert a compound fracture into a simple one by mechanical sterilization which

aims to expose the fracture site to vision by the excision of all the damaged and devitalized tissues. This débridement and primary suture is reserved for selected cases, and we do not practise it when the injury is more than twenty-four hours old. The safest procedure in converting a compound into a simple fracture is to resort to primo-secondary or delayed suture in which all steps, except suture, are taken and the actual suturing is performed after the third day when we are assured clinically and bacteriologically of the asepsis of the wound. An already infected fracture is a problem in osteomyelitis, and treated as such.

4. *Introduction of Non-absorbable Materials.*—We accept as a “necessary evil” the occasional use of non-absorbable material to act as an internal splint, but it should be the last resort, even in selected cases. Infection after plating or wiring is a regrettable occurrence in the leg or arm—in the thigh it has often been a tragedy.

5. *Articular Activity.*—With intra-articular fractures, or fractures very near to a joint, early active motion is of the utmost importance. Immobilization in the case of hæmorrhage into the joint will cause fibrinous adhesions which at length become fibrous. Intra-articular fibrous bands lead to bony ankylosis. Active motion causes the blood to be absorbed quickly and keeps the joint in a supple condition. For this reason, in any fracture near a joint with a concomitant synovitis, a preliminary aspiration of the joint is our routine. The hip-joint is the only exception to this rule.

6. *Non-union.*—This really means mal-union, the result of faulty reduction or retention. The next commonest cause for non-union is interposition of soft or hard parts (muscles, fascia, tendon, bone, etc.), and is in effect a spontaneous arthroplasty. Syphilis we believe not to be a common cause for non-union, for if it were so, non-union would be more common than it is. But we do believe that cardio-vascular disease, as well as focal infection, is a considerable factor in this process. As to frequency of non-union, the femur is fourth on the list, beginning with tibia, forearm, and humerus. Non-union of the fibula is a rarity, and is possibly explained by the large nutrient canal it has. Non-union in any joint fracture, except fracture of the neck of the femur, is exceedingly rare.

7. *Repair.*—All the above considerations are contributory factors in the process of repair. It is of note, however, both in time of occurrence and amount of deposition, that callus appears first and in greater quantity on the concave aspect of the shaft of the bone, demonstrating an engineering principle that the greatest support is given at the point of greatest strain. The antero-posterior curve of the shaft of the femur creates an arch with the weakest point about the middle of the bone—the point of greatest stress and the most common site of fracture of the shaft. Therefore, the importance of getting correct coaptation for the production of a strong bony repair.

These are some of the essential principles—they are the foundations upon which our treatment is based. What, then, has been our experience in treating this group of cases? Briefly stated, the answer is that all cases of frac-



ture of the neck of the femur are treated by adhesive traction and extension in a Gatch bed, and all others of the Type 2 (non-displaced) are treated in a plaster-of-Paris cast or in a Thomas or Blake-Keller splint. All Type 1 fractures below the neck are treated by transfixion.

*Neck of Femur Group.*—Generally speaking, patients with fracture of the femoral neck—using their age and physique as a standard—can be arbitrarily divided into three classes of risks—the good, the fair, and the poor—and treatment is accorded with this grouping in mind.

Those in the fair and good groups, because of a tolerant physique, may be placed in an abduction plaster-of-Paris case, following traction and extension in a Gatch bed. This preliminary application of traction facilitates reduction by tiring the muscles in overcoming spasm, and allowing of easier manipulation of the fracture.

Where the physique is poor or bad, any confinement in a fixed position may prove a catastrophe. Therefore, in some cases all that need be done is to place a pillow or sandbag along the outer side of the limb to prevent external rotation. Where displacement is present, placing the patient in a Gatch bed with the knee flexed and the thigh internally rotated with a weight of 5 to 20 pounds attached to it by means of adhesive straps led over the foot of the bed, which is elevated about twelve inches, will often reduce the overriding and maintain the fragments in apposition to allow of union. Any of these means will tide a patient over the stage of shock, hypostatic pneumonia, or other medical or surgical complication. Later, when conditions permit, a plaster-of-Paris abduction case may be applied, or this same mode of traction and extension may be

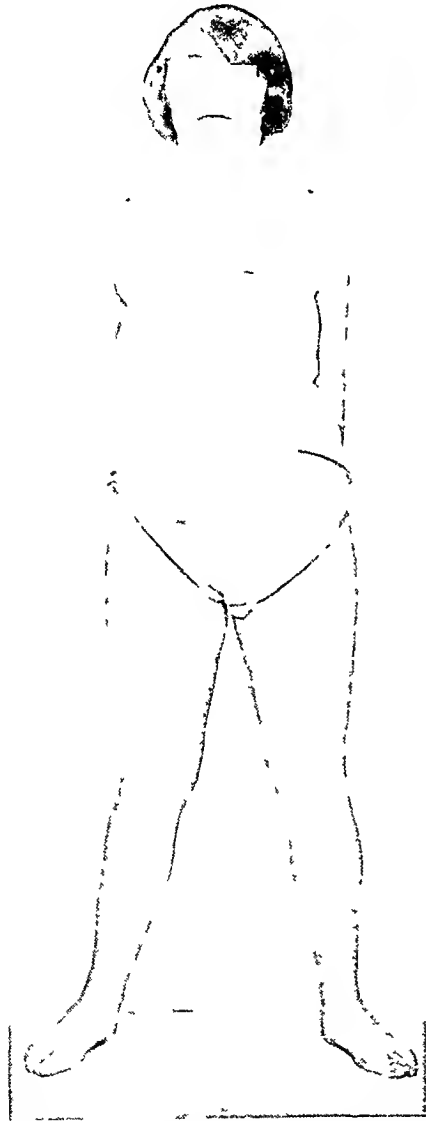


FIG. 5—Functional end result three years later. One quarter inch shortening.

maintained until union is established. Lately, we have been using this throughout the entire period of treatment, and found that union often occurred earlier and was stronger than when immobilization in a case was used.

When the abduction case is used, it is left on for six weeks and then removed, examining the fracture site for the presence of union which often is of sufficient strength to allow the patient to be up and about in a pair of

walking callipers (Thomas splint with waist band) and crutches. This permits of locomotion, but no weight-bearing, and early access for massage of the different parts of the limb. This is worn until union is solid, by which we mean that weight-bearing on the extremity will not give a reaction at the fracture site in terms of pain, swelling, or disability. We differentiate between early and late union. The former we call firm when the patient is able to elevate the foot off the bed, and the latter we call solid when no reaction is given at site of fracture as above.

Many patients can discard the brace at the end of four months, but the majority need some support for six months. If, when the case is removed, no evidence of union is present, a new plaster case is applied and left on for four weeks, at the end of which time in most cases union will be present.

*Fractures Below the Neck.*—As previously stated, all Type 2 (those with non-displaced fragments) are treated in (1) a plaster-of-Paris case (2) an antero-posterior moulded plaster-of-Paris splint, or (3) in a Thomas or Blake-Keller splint. The fragments in this group are not overlapping, hence there is no gross deformity, the bones are aligned and the carrying angle is correct, and our aim is to hold the position unchanged until there is firm union. For, it is reasonable to assume that, if the violence of the accident caused no displacement of fragments, any subsequent displacement will result only by injudicious management.

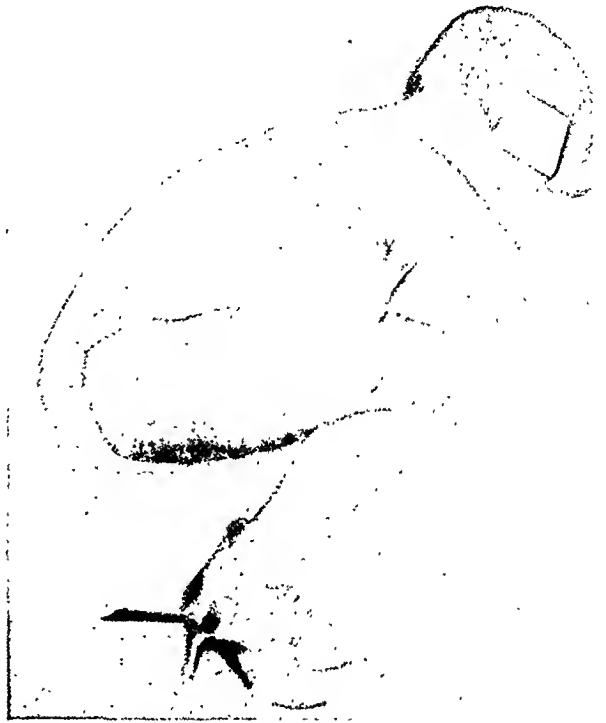


FIG. 6.—Dimple above external condyle of right femur shows site of entrance of nail.

All Type 1 (those with displaced fragments) are treated by transfixion unless the musculature of the individual is frail or the displacement of the fragments is small, when reduction can be accomplished readily on one of the traction tables. Transfixion is applied as soon as possible, and general anæsthesia is preferable, but spinal or even local anæsthesia can be used. Of the general anæsthetics, we prefer the following in the order given: Nitrous oxide, ethylene, or by drop method, ether or ethyl chloride.

*Site of Election.*—For shaft fractures, this is about two and one-half inches above the condyles. For supracondylar fractures, through the condyles, and for condylar fractures, through the head of the tibia. The bony landmark in each site is the internal condyle.

*Introduction of Nail.*—The flexed and iodinated knee is rested at an angle

of  $165^{\circ}$  over a sandbag. At the site of transfixion, the skin is drawn upward and a vertical incision one-half inch long is made on the outer side of the limb on a line bisecting the greater trochanter and external condyle. A director is introduced into the incision and the center of the bone located. This is important as otherwise the popliteal space, or the synovial area may be entered. The three-sixteenths inch transfixion nail (Steinman nail) is then introduced over the director, which is then removed, and with gentle repeated tapings with a bone mallet, the nail is passed through the bone, while an assistant steadies the part and maintains counterpressure, making sure all the time that the nail is being held at right angles until it transfixes the bone and impinges against the skin on the inner side opposite the place of entrance. The skin here is now also drawn upward, and an incision one-half inch long also made and the nail allowed to pass through at the top of it. Any pressure by the nail upon the skin will cause acute pain; hence the caution to prevent this by drawing the skin upward before making the incisions. At least one inch of the nail is allowed to project on either side of the limb.

*After Care.*—The nail being introduced, the skin wound is covered with a wet dressing of a mild antiseptic, and for this purpose we use a solution of iodine, dram  $\text{I}$ , to sterile saline, pint  $\text{I}$ . Dry gauze and cotton are applied over this after the “spreader” has been fastened to the ends of the nail and bandaged over to form a fairly secure but not too tight dressing, allowing for freedom in flexion of the knee. This dressing is changed at the end of forty-eight hours, and again every other day for ten days, until the nail is removed. There will be more or less serum around the skin wound due to irritation of the nail, but seldom any infection.

Thus secured, traction is maintained on the lower fragment while the patient is being transported to bed, which is elevated twelve inches at its foot. A cord passes over the pulley at the foot of the bed, and a weight of thirty to forty pounds is attached to the end of the “spreader.” Both knees are kept at an angle of  $165^{\circ}$ —that is, just off a straight line—and the direction of traction is always in the long axis of the upper fragment. To keep the knees properly flexed, we use (1) a bolster passed under the mattress, (2) a Gatch bed, (3) a Thomas splint with a knee piece, or (4) a Hodgen splint.

An overhead frame of the Balkan type will give the best type of support for the apparatus, and also provides a “perch” for the patient to pull upon. Attention to the knee-joint motion is given from the start, as the patient is provided with an overhead cord which is fastened to the ankle or to the sole of the foot, and daily the knee-joint is moved by the patient so that any fixation of the joint from the accompanying synovitis is avoided.

In supracondylar fractures, it is always advisable to flex the knee somewhat beyond  $165^{\circ}$ ; otherwise the gastrocnemius will continue to contract, thus interfering with coaptation. In the sub-trochanteric and upper third of the shaft regions, the upper fragment will be in abduction, and hence the direction of traction must follow this direction by placing the traction cord,

pulley, and weight, so that wide abduction is possible. A good plan in obtaining this is to have the patient's foot on the injured side on a line with the umbilicus and opposite shoulder. Flexion of the knee automatically flexes the thigh on the abdomen, and thus the contraction of the ilio-psoas group is relaxed by the same procedure which relaxes the gastrocnemius group.

Periodic examinations of the limb will determine whether or not over-lapping has been overcome, and when false motion, crepitus and laxity of the muscles are noted, measurement or X-ray examination will show that the deformity has been overcome or sometimes even a separation of the fragments created. With this established, the traction is discontinued and the nail removed. This is done by flaming the end of the nail to be pulled through, or sterilizing it with tincture of iodine, and, with an artery clamp applied to the opposite end, a gentle rotary motion will free the nail, making its removal easy.

After the removal of the nail, a sterile dressing is applied to the sites of entrance and exit of the nail, and a cast is applied to the limb, reaching from the hips to, and including, the toes. This is left on for four weeks, at the end of which time it is removed and the site of the fracture is examined for the presence of union. This we call "firm" when manipulation gives no evidence of false motion, and "solid" when weight-bearing gives no local reaction in terms of swelling, heat, or pain. If firm union is present, the plaster case is left off, and a pair of walking callipers is applied which the patient wears constantly until unaided weight-bearing is established.

With the application of the walking callipers, physiotherapy is at once instituted, and maintained up to and beyond the time that it is removed, so that when the protective brace is discarded—which is anywhere from two to four months after its application—the patient has a fairly good functioning limb well on towards the ultimate goal in the treatment, a good functional end-result.

In the 100 cases reported here, traction was used in 54 cases, and non-traction in 46 cases.

Skeletal traction was used in 42 cases as follows:

Steinman nail	39 cases	Males 34, Females 5. Of these 4 were children under twelve years.
Traction callipers	2 cases	
Finochietto stirrup	1 case	

Adhesive traction (neck of femur cases) was used in twelve cases.

*Site of Nail Traction:* Shaft of femur, 32 cases; head of tibia, 6 cases; os calcis, 1 case.

Average duration of nail traction was 17 days.

Longest duration of nail traction was 38 days.

Shortest duration of nail traction was 4 days.

Average duration of traction callipers was twenty-nine days.

Duration of stirrup traction was thirteen days.

The oldest patient on whom a nail was used was seventy-one years old; the youngest, nine years.

The average duration of post-traction immobilization in plaster-of-Paris case was forty-two days; longest ten weeks; shortest thirty-six days.

#### Operations performed:

Oblique osteotomy for mal-union with transfixion..... 9 cases  
Open correction without nail..... 6 cases  
Amputation ..... 1 case

(Admitted with osteomyelitis of femur and sepsis with spontaneous fracture—pathologic)

Complications.—One case of osteomyelitis of nail passage due to use of short nail. One case of osteomyelitis of nail passage due to too long retention of nail.

Deaths.—One case admitted with fracture of neck of femur, bronchopneumonia—age eighty-one years. Died within forty-eight hours.

*Grading* or evaluation of end-results is an attempt to give numerical standards to the desired triad in the treatment of fractures; *viz.*, function, union, and contour; and because we feel that function is the most essential of these, we give it a valuation of 60 per cent. out of a possible 100 per cent. To union and contour, we give a valuation of 20 per cent. each. These standards, to be sure, are arbitrary but give a numerical uniformity of understanding end-results, and are—to our minds—far more satisfactory in producing a fixed basis of comparison, than the elastic terms of fair, good, or perfect.

An attempt at follow-up was made on the cases reported, and only twenty per cent. responded. Letters of inquiry with questionnaires were sent out to the remaining 80 per cent., but answers proved insufficient as a basis for report. Of the twenty patients that showed up, the post-treatment time ranged from one to seven years. Twelve of those who reported were treated by transfixion with the nail; eight were non-traction cases. The anatomical lesions of those that reported were as follows:

#### Skeletal Traction:

Shaft of femur 9 cases  
Supracondylar 3 cases

#### Non-traction:

Shaft of femur 5 cases  
Neck of femur 3 cases

Graded by types, the twenty cases gave the following findings:

No.	Type	Func. Per cent.	Union Per cent.	Cont. Per cent.	Total Per cent.
1. Case 2—Middle shaft—Nail traction.....	1	50	18	10	78
2. Case 3—Shaft—Non-traction .....	2	55	20	15	90
3. Case 5—Neck of femur .....	2	60	15	20	95
4. Case 10—Left neck and right lower third— Nail traction .....	1	30	10	15	55
5. Case 18—Supracondylar—Nail traction .....	1	60	15	20	95
6. Case 35—Middle third, shaft—Nail traction.	1	50	20	15	85
7. Case 39—Neck of femur—Non-traction ....	2	50	15	15	80
8. Case 42—Lower third—Nail traction .....	1	45	15	15	75
9. Case 48—Upper third—Nail traction .....	1	55	20	15	90
10. Case 50—Neck of femur .....	2	40	10	15	65
11. Case 52—Upper third—Nail traction .....	1	55	20	15	90
12. Case 53—Supracondylar—Nail traction bi- lateral .....	1	35	12	15	62

# FRACTURE OF THE FEMUR

No.	Type	Func. Per cent.	Union Per cent.	Cont. Per cent.	Total Per cent.
13. Case 57—Lower third—Nail traction . . . . .	1	35	15	15	65
14. Case 60—Upper third—Nail traction . . . . .	1	55	20	20	95
15. Case 67—Middle—Nail Traction . . . . .	1	50	20	20	90
16. Case 70—Upper third—Non-traction . . . . .	2	55	20	20	95
17. Case 83—Middle third—Non-traction . . . . .	2	60	20	15	95
18. Case 89—Supracondylar—Nail traction . . . . .	1	40	15	10	65
19. Case 94—Lower third—Non-traction . . . . .	2	55	20	20	95
20. Case 98—Upper third—Non-traction . . . . .	2	55	20	15	90
Total average		47	17	16	80

## RESUMÉ

1. Uniformity of classification, treatment, and grading—as followed in the above series of 100 cases of fracture of the femur—is a step toward standardization in the management of all fractures.

2. Judged by this series, fracture of the femur seems to be an injury occurring more in adult life than childhood—the proportion being about three to one.

3. Fracture of the neck of the femur is more common in females, whereas fractures of the shaft occurs more commonly in the male.

4. Transfixion with the Steinman nail in displaced fractures of the shaft or supracondylar region has given uniformly good results in all of the thirty-nine cases tried.

5. In old fractures, with mal-union and shortening of the bone, it is the best means at our command in overcoming contracture of muscles, if applied after the separation of the mal-union by osteotomy.

6. In non-union due to interposition of soft parts, it will often—by pulling down the lower fragments—release the interposed part and allow manual adjustment of the fragments without resorting to an open operation.

7. There was no breakage of the nail.

8. No infection occurred at the transfixion site, except in two cases due to the use of a short nail and too long a traction time, respectively.

9. With the use of a moderate amount of care, the introduction of the nail is a relatively simple procedure, and may be done at the patient's bedside.

10. Transfixion treatment in supracondylar fractures by allowing movement in the knee-joint prevents fibrous adhesions, with a consequent earlier restoration of knee-joint function.

11. This series of typical cases would indicate that the treatment of fracture of the femur resolves itself into the following:

(a) Children up to five years to be treated by overhead suspension.

(b) Fractures of the "neck" zone to be treated by traction and extension in a Gatch bed.

(c) Fractures in all other zones of the displaced type to be treated by skeletal traction, of which transfixion is our choice.

Note: The writer is indebted to Dr. J. J. Moorhead, director of the Department of Traumatic Surgery, the use of whose cases made possible the greater part of this paper.

## TREATMENT OF FRACTURE OF THE NECK OF THE FEMUR IN THE AGED

BY JOHN E. CANNADAY, M.D.  
OF CHARLESTON, W. VA.

THE appropriate treatment for fracture of the neck of the femur depends to a very great extent on the age and general condition of the patient. I believe it is generally conceded by the surgical profession that the aged or otherwise feeble individual having a fracture of the neck of the femur constitutes a special problem. It is commonly said, and with good reason,



FIG. 1.—Plaster-bandage fixation of fractured neck of the femur. Anterior view.



FIG. 2.—Plaster-bandage fixation of fractured neck of the femur. Side view; sitting posture.

that it is dangerous to confine an old person to bed. Two serious complications are often incidental to fracture of the neck of the femur in the aged: Pneumonia and bedsores. The former presumably often starts as a hypostatic process. In such patients the advantages of an ambulatory or semi-ambulatory method of treatment are obvious. Again, particularly in case of female patients, who are being kept on the back, it is often difficult to prevent soiling of the plaster case during the act of urination; certainly so if a bedpan is used; the same problem arises after the administration of an enema.

## FRACTURE OF THE NECK OF THE FEMUR

Many surgeons have advocated treating these patients by the use of traction or sandbags, or both, meanwhile keeping them on their backs. My observation is that if such patients escape pneumonia they usually develop bedsores. In the treatment of such cases occurring in my service in the Charleston General Hospital, I have for the past several years advocated and practiced the application of a plaster case in a modified Whitman position. I call it the sitting Whitman position. The position is somewhat like the position used after the reduction of a congenital dislocation of the hip.

In these cases, it is advantageous to apply the case early after the fracture, before overmuch muscle contraction has taken place. Before applying the case, if practicable, the leg should be brought down by traction so as to compare in length with the other leg. On the fracture table, the legs are placed in a position of rest, the thighs flexed on the body at a right angle

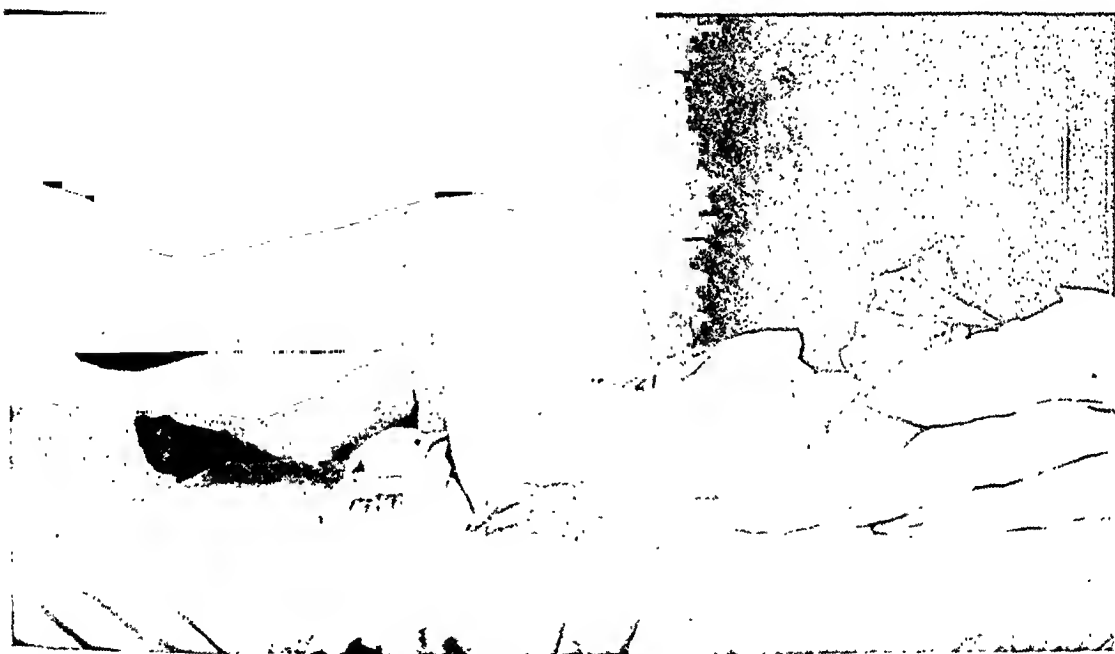


FIG. 3.—Patient supine.

and the legs at right angles to the thighs, the thighs abducted in the Whitman position. The fractured limb is held in internal rotation as well, the Hawley or other fracture table supporting the patient's hips, shoulders and knees. The case starts at mid-chest, includes a spica of the pelvis, thigh, leg and foot as well as the thigh of the unaffected side. The legs are held in position by assistants. Meanwhile traction should be made in line with the body by a bandage pull around the upper part of the thigh so as to overcome any tendency of the femur to slip upwards. The case is applied in sections—first, the body, spica of the pelvis and thighs, then the transverse spreader bar between the knees, the leg and lastly the foot; all at one sitting of course. A preliminary hypodermic of morphine obviates any necessity for general anæsthesia. In order to expedite the application of the case and thus to conserve the patient's strength, the services of a well-trained team of six or seven individuals are desirable.



As one infers from the photographs (Figs. 1-4), the patient can be easily shifted into numerous positions. The sitting and prone positions seem to be the most comfortable in the average case. As the patient has the liberty rather than the confinement of a case, a surprising degree of physical well-being is maintained. As a rule, we find it desirable to change the patient's position every two or three hours or oftener if the patient is not comfortable. Most of the patients sit up in a chair for the major portion of each morning and afternoon, the meals are usually taken in that position, reading or some variety of handwork helps to keep up the morale of the patient. Old people are often hypersensitive to pressure from a case and unless the case is applied with extreme care by one familiar with such procedures, the patient will not be comfortable.

In the aftercare, it is essential to have the services of a nurse who understands how to make her patient comfortable by means other than a hypo-



FIG. 4.—Patient prone.

dermic of morphia. Change of position often is all that is necessary to relieve the pain and discomfort incident to the condition. Most of our patients have obtained bony union; neither bedsores nor hypostatic pneumonia has occurred when the case has been properly applied and the patient has had reasonably intelligent care.

The knee is usually freed at the end of the sixth week, at which time the spica of the well thigh and the spreader bar are also removed. The remainder of the case is removed seven or eight weeks later. Previous to the removal of the case from the foot and leg so as to allow free knee motion, a window is cut anteriorly in order that the patella may have the benefit of passive motion—as is obvious, if the knee is kept fixed for an undue length of time there will be soreness and stiffness that may require considerable time and effort to overcome. No stiffness or ankylosis of the knee or hip joints has been noted in any case handled in strict accordance with the above outline.

## EXPERIENCES WITH VENOCLYSIS \*

BY GEORGE A. HENDON, M.D.

OF LOUISVILLE, KY.

I HAD the privilege of reporting my earlier work with this mode of intravenous administration before the Southern Surgical Association at Charleston in December, 1924. At that time I first proposed the word "venoclysis" as definitive and descriptive of the process I was advocating. As no better, in fact no other, term has appeared, I still adhere to its use. It is a pleasure for me to remind you by a repetition of the acknowledgment of credit which I gave at that time to Matas, who originated the idea. The following is a quotation from my article: "On May 12, 1924, I first employed the method and again in June, 1924, as a result of a paper on the 'Continuous Intravenous Drip' by Dr. Rudolph Matas, read before the American Surgical Association in June, 1923." The paper was published in the ANNALS OF SURGERY in May, 1924.

My first case was in May, 1924, before the appearance of Matas' article, but I had seen more or less condensed extracts that had winged their way through the current literature of the intervening period. Those who may be interested in the fundamental principles involved are referred to my article in the *Transactions of the Southern Surgical Association* for 1924 and to Matas' original contribution in the ANNALS OF SURGERY for May, 1924.

There are a few historical points of interest concerning intravenous administrations that seem to be of sufficient importance to include in this presentation. The first account we have of intravenous medication is found in Boyle's book on the "Usefulness of Experimental Philosophy" published in 1720, a quotation from which is herein produced. The experiments noted here were done in 1656.

I may here mention some later experiments made to show the effects of liquid poisons conveyed immediately into the blood, and particularly that famous one of Mr. Christopher Wren, who contrived a new way of injecting them. I procured a large dog, into the vein of whose hinder leg we conveyed, by a syringe, a small dose of warm solution of opium in sack. The effects whereof became manifested as soon as we could loose the dog from the cords wherewith his feet were tied, for he immediately began to nod and reel as he walked, whereupon, to preserve his life, I ordered him to be kept awake by whipping, which after some time brought him to himself, so that he soon grew fat upon it. The same gentleman at another time, injected in the same manner about two ounces of Vinum Benedictum, which operated so violently that it soon killed the dog.†

It is astonishing to note that the Mr. Christopher Wren, mentioned in this connection, afterwards became Sir Christopher Wren, the famous architect who designed and built the dome of St. Paul's. It is noteworthy indeed,

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\* Read before the Southern Surgical Association, December, 1929.

† Robert Boyle: *The Usefulness of Philosophy*, vol. i, p. 38.

that at the age of sixteen he was prosector of anatomy to Doctor Scarborough at Oxford.

Dr. J. M. Fortescue-Brickdale, in *Guys Hospital Reports*, vol. lviii, 15-8, has presented the history of intravenous medication to 1904. The high points are as follows: Wren, 1656 (on animals only); Hayem used saline infusion for cholera in 1855; Bacelli used quinine infusion for malaria in 1890; Crede used colloidal silver injections for infections in 1901. Since that time intravenous medication has become universal and generally understood. But intravenous nutrition to the exclusion of all other efforts to supply nourishment might be acknowledge to have begun with the case I treated in June, 1924. Our experience has demonstrated beyond any doubt that venoclysis renders one entirely independent of the gastro-intestinal system so far as nutrition and liquidation is concerned. When the ease, safety and simplicity of the procedure is more generally and more thoroughly appreciated, venoclysis will become the method of medication in most serious and acute diseases. For our own convenience we have devised a cannula made of silver and plated with gold, to prevent corrosion. The point is rounded and blunt and there are openings in the sides and none at the end. This we believe renders it less liable to become clogged by a clot of blood or loose tissue. Should a clot form and become dislodged it would not go directly into the current of the fluid but would be more likely to adhere to the wall of the vessel because of the close contact of the cannula.



FIG. 1.—The cannula.

The technic is to expose either the basilic or the cephalic veins (preferably the basilic) immediately above the bend of the elbow under local anæsthesia after a tourniquet has been applied to arm above. With an aneurism needle a piece of umbilical tape of convenient length is carried beneath the vessel. The distal end is tied with a catgut ligature before the vein is opened. The vessel wall is then picked up, the tourniquet loosened and the vein wall opened with a manicurist instrument called "cuticle nipper." The cannula is introduced into the vessel lumen beyond its shoulder and the vein tied behind its shoulder with umbilical tape and tied in front with the same material. Before the operation is started the apparatus should be assembled and the bottles filled with the solution which is intended to be employed. The fluid is allowed to flow until the air is expelled and the connection is then made to the cannula with a piece of rubber catheter or other high-grade tubing about four inches long. I find it useful to purchase Eyenard catheters and cut them into convenient lengths for that purpose because they seem to be composed of highly vitalized rubber which renders the connection thus made easy of accomplishment and assured security. The flow is now allowed to begin in a small stream for a few moments to insure the patency of the cannula. It is then throttled down to the required rate and the wound is closed with catgut sutures. A sterile gauze dressing is applied over the incision, the tubing bound tightly to the forearm with

## VENOCLYSIS

strips of adhesive plaster that encircle the limb at intervals down to the wrist. A loop of muslin bandage is carried lightly around the wrist and tied to the bed railing to prevent damage being done by involuntary movements during sleep. Splinting is not necessary. The patients may assume any position in bed that they desire.

The apparatus for holding and conveying the fluid consists essentially of two thermos bottles, quart size, and a staff about six feet high to suspend them. The bottles are provided with brackets made of wire that will permit them to be suspended in an inverted position and with Wolf stoppers containing two holes, one for an air tube and the other to provide an outlet for



FIG. 2.—The venoclysis apparatus in operation.



FIG. 3.—Venoclysis; showing possible self-regulation of supply.



FIG. 4.—Venoclysis; showing possible natural position for taking nutrition.

the fluid. Over this tube is fitted a piece of stethoscopic rubber tube about ten inches long. The other end is fitted over one arm of a glass Y. The opposite limb of the Y is joined in the same manner to a similar piece of tubing which is also attached by its other end to the tube in the second bottle. Each segment of the tubing is provided with a stopcock regulated by a screw. The stem of the Y is joined to another section of stethoscopic tube about three inches long, to the other end of which is joined a Murphy visible dripper and in the middle of the tube is a stopcock similar to the above. The lower end of the dripper is in turn joined to another piece of stethoscopic tubing about twenty-four inches long at the lower end of which is attached a glass irrigating nozzle to connect with the piece of catheter that joins the cannula.

The equipment can all be sterilized by boiling except the thermos bottles. These I keep filled with Dakin's Solution while they are not in use; immediately before using them I pour out the Dakin's and rinse with sterile water.

The rate of the flow is regulated so that the patient, if an adult, receives not less than four thousand nor more than six thousand cubic centimeters of 10 per cent dextrose in twenty-four hours. It is interesting to observe that the urine output is in most cases approximately one-half the amount of fluid thus administered.

The fluids used are sterilized in the usual way. When using dextrose solution we employ the anhydrous product and dissolve only enough at a time to last twenty-four hours as it undergoes decomposition when kept longer. The dextrose solution will not admit of boiling but can be sterilized by exposing it to 15 pound steam pressure for ten minutes. If a dextrose solution turns brown it is unfit for use.

We have at different times and in different cases used Ringer's solution, Fischer's solution, normal saline, dextrose in normal saline and dextrose in plain sterile water. Much experience and the reports of many observers will be required to furnish information as to the numbers of remedies that can be best administered in this way. Our own experience has only proceeded far enough to supply assurance that the method is safe, simple and accurate. Formerly maintenance of the proper temperature was a matter of much concern. We usually aim to deliver our fluid to the vein at 100° F. That requirement is easily met by placing it in the thermos at 120°, or by calculating so as to allow a loss of 5° F. in transit for each foot of tubing traversed. In case of shock or subnormal temperature fluid can be supplied to the blood at 120° F. without hæmolysis and is of immense value in restoring body heat, thereby relieving algid conditions. The fluid can be administered by venoclysis, at room temperature or as low as 60° F., to control excessively high temperatures. As to rapidity of administration I have found it practical to give 150 to 200 cubic centimeters per hour.

Increased lachrymal secretion or œdema of the lids is regarded as evidence of saturation. I have seen only one case. The quantity is then reduced or the flow discontinued. If dextrose is being given the urine is examined daily and as long as only a trace of sugar appears the administration is not disturbed but when percentages occur even 1 per cent the concentration is diminished. We find that any toxæmia whatever will consume large amounts of dextrose. I have given 600 grams of dextrose in eighteen hours in a severe case of septicæmia and 500 grams daily for five days in pernicious vomiting without any glycosuria but with immense relief of pain and much benefit to the patient. While in a case of gastric ulcer that I treated, 250 grams daily was all the patient could take without the sugar appearing in the urine in 1 or 2 per cent proportions. The glycosuria we do not regard as a danger signal. The concentration is reduced, however, because there could be no useful purpose accomplished by allowing an excess of sugar to circulate in the economy.

In an experience covering a period of six years and more than 150 cases I have never met with a serious accident or grave complication that could be ascribed to or connected with this method of treatment. Neither air embolism nor clot nor phlebitis has appeared as a complication and the operation wounds have healed perfectly and promptly without undue soreness or disability in the arm. Neither has the circulation become in the least embarrassed by the destruction of the vein that was employed. The cannula is easily removed when the treatment is completed. No bleeding follows its withdrawal because the vein in which it was lodged ceased to function as a conveyor of blood as soon as the fluid began to flow through it to the general circulation. I shall report briefly a few cases with the most surprising results.

In my list are eleven cases of emesis gravidarum upon whom some of our best obstetricians had used all the known methods of treatment except the induction of abortion. These women, one of whom was unconscious when the treatment was begun, was given 5,000 cubic centimetres daily of a 10 per cent solution of dextrose. They were under treatment from three to five days. All recovered. One of them died four weeks after going home from intestinal hæmorrhages of undetermined origin. She was in the fifth month of her pregnancy.

CASE XII was a woman who had been ill seven weeks with a staphylococcic blood-stream infection with irregular chills and temperature ranging from normal to  $104^{\circ}$ , excessive diaphoresis, exhaustion and very rapid pulse. After seventy-two hours' treatment, during which time she received 15,000 cubic centimetres of a 10 per cent dextrose solution her temperature became normal with the exception of an evening rise to  $101^{\circ}$ , which continued but a few days. No other treatment was employed. She left the hospital in two weeks completely recovered and has since regained her natural weight and strength.

CASE XIII was a woman who had been sick about a year with what her physician diagnosed as pernicious anæmia. All the known methods of treatment, both medicinal and dietetic including liver feeding, had been tried in vain. Her blood count was one million and nine hundred thousand. Her revulsion for food was so intense that she was literally starving. Extreme muscular exhaustion prevailed to such an extent that she was unable to turn over in bed without assistance. After seventy-two hours of treatment in which we gave 15,000 cubic centimetres of a 10 per cent solution of glucose her red blood cells rose to two million and five hundred thousand. She began to eat normally, the count rose in a few more days to three million and she has gained forty pounds in weight.

CASE XIV was a man suffering with intense jaundice, sick four weeks, severe pain, irregular chills, temperature ranging as high as  $104^{\circ}$ . His abdomen was opened under the diagnosis of obstructive jaundice; a stone was thought to be lodged in the common duct. Instead of that was found a condition of multiple abscess of the liver with no obstruction of the duct. The gall-bladder, which was opened, contained about one dram of normal-looking bile. A tube was placed in the gall-bladder for drainage but nothing flowed from it until about one week after the operation. In three days his jaundice had disappeared and he proceeded to complete recovery but was attacked two months after operation with severe recurrent pains in the upper right quadrant. His abdomen was

again opened and the gall-bladder removed. The liver which was at the previous operation very much enlarged and very soft now appeared normal in size and consistency. The patient made a prompt recovery and has remained so except an occasional attack of pain in the upper right abdominal quadrant, the cause of which I am not able to determine. He is now fully recovered and working regularly at his trade as a plumber.

CASE XV was a man who had suffered an avulsion of the left arm at the shoulder-joint by being caught in the machinery of a cement mill. He was unconscious and in profound shock. As soon as he could be gotten to the operating table the venoclysis with a 10 per cent solution of dextrose was begun and continued while the flaps were being fashioned and adapted to cover the head of the scapula. The nerves and tendons stripped of their coverings hung down to his waist and presented a gruesome spectacle. These were trimmed smooth and the axillary artery tied. The skin margins approximated so that a very presentable stump was obtained. The venoclysis was continued forty-eight hours, at the end of that time all evidence of shock was gone and the patient made an unusually quick recovery.

CASE XVI was a girl twenty years old, who had suffered with osteomyelitis of femur s'nce childhood. She had undergone numerous curettements. She had several discharging sinuses. The limb was totally useless. She came to me requesting an amputation. I did not suppose she could endure a hip-joint disarticulation so I amputated through the continuity of the shaft as high up as I could without invading the joint. The bone being in a state of septic necrosis when sawed through naturally infected the operative field. The evening of the second day her temperature rose to 104°, pulse 140, and she became delirious. Venoclysis was then started with 10 per cent dextrose. Six thousand cubic centimetres were given in eighteen hours. Her temperature came down to normal and pulse to 100. The venoclysis was now discontinued. Her temperature remained at normal with a slight evening rise. She made a complete recovery.

CASE XVII.—Mrs. W. had been operated on one and a half years previously for gastro-duodenal ulcer. A gastro-enterostomy was done. She derived some temporary relief but her former symptoms returned in all their original severity, including one very alarming hæmorrhage. It was decided to give the stomach and duodenum a period of complete rest before attempting any more surgery. After a thorough understanding of what we proposed to do and the purpose had been explained as well as the novelty of the procedure we started her off on a 10 per cent solution of dextrose at the rate of 5,000 cubic centimetres a day. No other form of nutrition was allowed. About the second day her urine showed 2 per cent sugar and the concentration of the solution was reduced to 5 per cent. From thence forward her urine showed only a "trace" of sugar. After six days her arm began to show some redness about the cannula and became slightly painful, upon which it was decided to transfer to the other arm. A rest of two days was allowed, during which time she was fed on cereals with cream and sugar. When the treatment was begun again, all gastric feeding was discontinued and the treatment continued seven days. The patient was then fed on cereals with gradual expansion of diet and she felt so much relief she declined operation and her improvement has continued since her return home. Now fourteen months have elapsed since her discharge and there has been no return of her ulcer symptoms.

CASE XVIII was a man who had visited various clinics over the country during a period of five years. He had the typical ulcer symptoms, including hæmatemesis. He took the treatment one week and declined to continue any further. His gastric symptoms were completely abated while the treatment was in process. His subsequent history has been impossible to obtain.

CASE XIX was a child four and a half years old who had been sick ten weeks. He had been under the care of Dr. P. F. Barbour and Dr. Cleves Richardson. He was intensely jaundiced, very weak with temperature ranging to 107° per rectum. His urine was scant and coffee-colored, he had abdominal ascites and an enlarged liver that extended down to the crest of ilium. I was asked to operate for abscess of the liver. After

## VENOCLYSIS

discussing his case with the attending physicians, we decided the abscess was multiple and operation contraindicated by his extremely low vitality and excessive temperature. The condition was agreed to be hopeless. Upon the very insistent urging of the attending physicians and the parents after they had been made fully aware of the purely experimental nature of the process, I consented to use venoclysis. We gave him 4,000 cubic centimetres of Ringer's Solution in thirty-six hours. The nurse phoned me in the night that the patient had suddenly swelled up all over and his eyes had swollen shut. I ordered immediate cessation of the drip. The next morning when I visited him I found him in a state of general anasarca, eyes closed and scrotum swollen until it was transparent. I was a little encouraged, however, because his urine had increased in quantity and was lighter in color. His temperature had come down to  $103^{\circ}$  rectal. From that time all his symptoms began to improve, his temperature range dropped to  $99^{\circ}$ - $101^{\circ}$ . The œdema gradually disappeared, as did also the jaundice; his liver gradually went down until when he left the hospital it was not more than two inches below the costal margin; and at the time he left the hospital he seemed entirely recovered except that his normal weight and strength had not been regained. I report this case empirically without any hypothesis to explain the results except the theory of dilution of toxins. This child is now perfectly well and normal in every respect one year after the treatment.

The nineteen cases above cited comprise a group that illustrate an application of the principles of venoclysis somewhat divergent from the original line of thought. The results indicate the wide range of its usefulness which is as yet unexplored and which offers a most inviting territory to students endowed with curious and scientific impulses. Venoclysis has served me a more useful purpose in the treatment of general peritonitis adynamic ileus than any other one remedy, allaying thirst, supplying nutrition, slowing and strengthening the heart action, quieting delirium and maintaining the action of the kidneys and reducing to a marked degree the very distressing emesis that characterizes this malady. But the mortality of this group remains very high yet. I am encouraged by the fact that now and then I am able to save a patient who, I am convinced, would otherwise have died. Especially is this true concerning late cases of intestinal obstruction.

I feel that the time is approaching when all treatment for acute toxæmias will receive both medication and nutrition in this way. I am constrained to believe that a dose of anything when applied to the blood-stream is illogical and unscientific because the entire load is imposed suddenly on the distributing and assimilating powers of the circulation, which by the sheer weight of the burden may be crushed and paralyzed into a state of helpless confusion. Hence the frequent evidences of shock as manifested by chills, fever and exhaustion.

If the same fluid be administered by venoclysis drop by drop as the heart beats it is free from intolerance, is distributed and consumed at a rate proportionate to its delivery and imposes no sudden or excessive demands upon the vital functions and fulfills the sublimest conception of "benevolent assimilation." When therapeutic agents are administered by the mouth, rectum or subcutaneous tissues, dosage is both rational and commendable because from these sources their entrance into the circulation is balanced by the process of absorption. This is a process that regulates the ratio of



supply and demand in the animal economy. This valuable stabilizer does not have the opportunity to function when substances are introduced suddenly and directly into the circulation. Hence one chief value of venoclysis is that it embodies an effort to imitate the normal operations that take place in nature's laboratory.

A summary of my clinical experiences to date in addition to the cases herein reported would include seven cases of peptic ulcer, in six cases there has been a complete arrest of symptoms and gain in weight of as much as twenty pounds in one case; two cases of septicæmia with blood-stream infection, both recovered; eleven cases of apparently hopeless pernicious vomiting of pregnancy, all recovered. One case of tularæmia in which the red blood count rose in twenty-four hours from 2,600,000 to 4,200,000 and in forty-eight hours to 4,900,000. The patient, although seventy-two years of age and had been sick three months, made a very prompt recovery. We have a series of about 100 cases of various intestinal lesions including obstruction, peritonitis and ulceration, in all of which comfort was afforded and in the majority recovery took place.

# TRANSACTIONS

OF THE

## PHILADELPHIA ACADEMY OF SURGERY

STATED MEETING HELD JANUARY 7, 1930

The President, DR. ASTLEY P. C. ASHHURST, in the Chair

CALVIN M. SMYTH, JR., M.D., Recorder

### ALLERGY AND ASTHMA IN POST-OPERATIVE ATELECTASIS

DR. WALTER ESTELL LEE and, by invitation, DR. HARRY B. WILMER and DR. HERBERT MARSHALL COBE read a paper entitled "A Report of the Incidence of Allergy and Asthma in a Group Developing Post-operative Atelectasis," for which see page 651.

DR. WALTER ESTELL LEE said that in the findings of allergy he was never convinced that what had been observed was the only etiological factor. Something must start the phenomenon of post-operative atelectasis and why 20 per cent. of these cases developed this was hard to explain. Two of these cases which had been presented proved that not only allergy but other factors are necessary. First the case spoken of as number three. This man had a right-sided herniorrhaphy. There was a definite history of asthma and he developed on the second day atelectasis on the right side. A year later, he came into the hospital and had herniorrhaphy on the left side and developed a massive atelectasis on the left side. This man has asthma, the result of pain and posture and he has one of the factors necessary. Another boy was operated on for appendicitis. He developed massive atelectasis but the interesting thing is that, although the boy is still allergic, eighteen months later he had a mastoid operation and nothing happened. As a matter of fact there are no recorded cases of post-operative atelectasis following herniorrhaphy on one side while the second one developed atelectasis following abdominal operation.

### OXYCEPHALIA

DOCTOR THOMAS A. SHALLOW presented an infant, aged four and a half months, male, white, who was admitted to the Jefferson Hospital, in the service of Dr. J. Chalmers DaCosta, with a history of having generalized convulsions.

The child had been delivered as a breech presentation after a very difficult labor. After birth he was not cyanotic nor was there any other symptom which led the physician in attendance to suspect the presence of birth hæmorrhage. The mother stated the child did not seem to be as observant as other children of his age. He was fed from the breast up to his admission to the hospital.

Suddenly, November 13, 1929, one week before his admission to the hospital, he had a generalized convulsion, involving both extremities—the attack lasted ten minutes. The same evening he had a similar attack which lasted twenty minutes. The following

day he had two attacks which were more aggravated than those of the first day. The mother states positively that the child did not observe objects as well as he had before the attacks. She was very apprehensive about his vision.

The family history was negative. The patient is a well-nourished male infant, not dyspnoeic nor cyanotic. The head is larger than normal in the vertical diameter. The fontanelles are wide open. The parietal bones are prominent. The eyes are fixed and staring; there is fairly good rotation but there is impairment of convergence. Eye-ground examination of the right eye: media clear, disc pale, central margin clearly defined. Left eye: similar. These conditions indicate the presence of primary optic atrophy of both eyes; paralysis of convergence.

The nasal passages and nasal septum are normal; the alveolar processes are normal; the hard palate is much higher than normal. The pharynx is normal. The chest and abdominal examination discloses no evidence of thoracic or intra-abdominal pathology. There is no deformity or muscular weakness of the extremities present. The reflexes are normal. Kernig's sign is negative.

Several diagnoses were considered: 1, hydrocephalus; 2, hæmorrhage of the new born; 3, tumor of the brain, based on (a) the history of convulsions; (b) the enlarged head; (c) the primary optic atrophy.

*Studies for the diagnosis of hydrocephalus.*—A lumbar puncture was done; the fluid was normal in appearance and was not under pressure. A needle was introduced into each lateral ventricle through the anterior fontanelle. On the right side the needle entered the lateral ventricle three centimetres from the scalp; the fluid was under moderate pressure, fifty-five cubic centimetres were removed. On the left side the needle entered the left lateral ventricle five centimetres from the scalp. The fluid pressure was decidedly greater on this side and seventy-three cubic centimetres of spinal fluid were removed from the ventricle. Air was introduced into each lateral ventricle corresponding to the amount of fluid removed, that is, fifty-five cubic centimetres of air were introduced into the right ventricle and seventy-three cubic centimetres of air were placed in the left lateral ventricle.

*Comment.*—It was thought, because of the distance traversed by the needle to reach the lateral ventricles, the child did not have a marked hydrocephalus. It was also noted that the level of the roof of each ventricle and the capacity of the ventricles varied.

Doctor Manges reported that the X-ray shows a head much higher than the normal; the sella tursica is small, the sutures at the base of the skull seem to be united. There is complete absence of convolution depressions on the entire table of the skull. Possibly it is too early to expect convolution depressions to appear, but the impression is that the brain is not in contact with the skull.

Figure 1 shows the location of both ventricles, the left ventricle on the lower plane than the right. Both lateral ventricles, while slightly enlarged, are not hydrocephalic. The third ventricle is many times larger than normal. The report of the X-ray examination furnished the added information that this child had a much higher head than normal, associated with fusion of the basal sutures. Its failure to demonstrate lateral ventricular hydrocephalus led to the consideration of a fourth possibility—*oxycephalia*, that interesting deformity which is called by some "tower head," by others "turmschädel," which is caused by early fusion of some of the sutures of the skull, preventing the normal expansion of the brain.

The etiology of turmschädel or tower skull is disputed. It is claimed by some that traumatism at birth is a factor in the production of synostosis of the sutures. It is claimed by others that rickets is the etiologic factor in its production. There seems to be no question in this case but that the child had been delivered after difficult breech labor. The long bones were X-rayed and Doctor Manges reported evidence of rickets in some of them.

On December 22, a number of weeks after admission to the hospital, the patient had a return of the convulsions with repeated general spasms of the flexion type involv-



FIG. 1.—Showing the position of both lateral ventricles and a greatly distended third ventricle. Showing over the right eye a collection of air in the basal cistern at the point of penetration of the base of the skull.

ing both extremities. The child was not unconscious but had between forty and fifty spasms within three hours. The seizures appeared to be the typical tetanic flexion spasms of the hands and feet seen in rickets—eliminating the possible diagnosis of birth hæmorrhage, which was made on the history of convulsions before the patient was admitted to the hospital. A spinal tap was done and the tetanic spasms subsided within twenty minutes. The reason for this was not clear.

The laboratory examinations failed to reveal anything of an unusual nature except a slight lymphocytosis.

On the basis of the above oxycephalia was the presumptive diagnosis, but the possibility of brain tumor had to be considered. If there were a brain tumor present, causing obstruction of the aqueduct, choked disc would have been noted, not primary optic atrophy; lateral ventricular hydrocephalus would have dominated over third ventricular hydrocephalus.

An encephalogram was done to determine the extent of the obstruction of the aqueduct. Only fifty-five cubic centimetres of spinal fluid could be obtained by spinal tap.



FIG 2—Showing the high head of Oxycephalia. The position of the floor of the skull with the anterior and middle fossæ almost on the same plane. At the arrow point showing the protrusion through the base of the skull into the pharynx representing the position of the collection of air in the region of the right orbit in Fig 1.

An equal amount of air was introduced. The X-ray picture showed some air in each lateral ventricle; most of the air was collected in the basal cisterna. Figure 2 shows a bulging into the pharynx from the floor of the skull. This finding is in accord with the observation of Towne (*A. J. M. S.*, 1928). In one of his reported cases the brain herniated into the nose; in another of his cases there was an erosion of the base of the skull. The reporter remarked that because of the peculiar conformation of the floor of the skull in oxycephalia there is mechanical obstruction at the aqueduct. In this case the ventricles are not on the same plane (Fig. 1). The drainage from the basal cisterna is

impeded, the basal cisternæ are distended, eroding the floor of the skull, making pressure on the optic tract and producing primary optic atrophy.

This case seems to confirm the belief that rachitis is the etiological factor in the production of the oxycephalia, because of the tetanic spasms and the presence of the X-ray manifestation of rachitis in the long bones.

DR. FRANCIS C. GRANT said that from the history of the patient and from an examination of the X-ray plates, he rather felt that this was unquestionably a case of oxycephalia. He believed that brain tumor may be excluded inasmuch as the child had a bilateral optic atrophy. The convulsions or spasms from which the child suffered, he believed, could be attributed to rickets. With regard to the ventriculographic pictures which Doctor Shallow obtained, it seems probable that the reason for the inequality may well be that all of the fluid is not removed from the ventricles which therefore are not completely filled with air. The fact that he was able to remove 128 cubic centimetres of fluid from both ventricles combined makes it obvious that the child has an internal hydrocephalus. This is confirmed by the enlargement of the third ventricle which usually occurs in this condition. With regard to the etiology of the cranial condition, Doctor Grant said that a tower skull is commonly produced by premature union of the sutures at the base of the brain. This prevents the floor of the skull from growing at the same rate as the vault; crowds together the structures at the base and may account for the optic atrophy here seen, by stretching the optic nerves within their foramina and expansion of the hydrocephalus by interference with the circulation of the cerebrospinal fluid through its channels on the base of the brain. With regard to treatment, it is not certain that we can do much after the suture lines at the base have become prematurely ossified. He has seen two cases in which the sutures of the vault became prematurely ossified which were relieved, temporarily at least, by linear craniectomy along the line of the sutures. The mechanical opening of the suture line permitted the normal expansion of the brain and relieved compression. He is extremely doubtful, however, whether this procedure is indicated in this particular case.

DR. BENJAMIN LIPSHUTZ said that in the interpretation of this ventriculogram the possibility of a large cavity of septum pellucidum suggests itself. The septum pellucidum is usually present as a thin, vertically placed partition which separates the anterior part of the two lateral ventricles from each other. It consists normally of two lamina enclosing a narrow median cavity known as the fifth ventricle (*cavum septi pellucidi*). Morphologically and embryologically it has no direct relation to the lateral ventricles. In approximately one in two hundred brains observed in neuro-anatomical laboratories of Jefferson Medical College, a very large cavity of septum pellucidum is encountered.

As the cavity of septum pellucidum enlarges, it causes an attenuation and thinning of its lateral walls, and in three instances an actual dehiscence was effected, thus establishing a direct communication between the cavity of septum pellucidum and the lateral ventricles. The enlargement of the cavity

of septum pellucidum may take place at expense of lateral ventricles. The position of this shadow is directly in median line and is in same plane as the lateral ventricles. In those instances where the cavity of septum pellucidum was very large, the roof of the third ventricle is greatly depressed.

## OBSTETRICAL PARALYSIS

DR. PAUL N. JEPSON, by invitation, read a paper with the above title for which see page 724.

DR. A. BRUCE GILL remarked that for the past several years he had had occasion to do a good deal of work in the anthracite coal region, and has found the condition quite prevalent there. The slighter cases recover function and all that is required in them is to prevent deformity. One does that by putting the arm in the position Doctor Jepson had described. After the deformity has become a permanent one, possibly it is best to do osteotomy accompanied by tenotomy. As regards operations upon the brachial plexus, there is considerable difference of opinion. There are few men who practise this routinely and the results rarely justify it.

DR. ASTLEY P. C. ASHHURST said that some years ago when the controversy between Dr. T. Turner Thomas and the proponents of the neurogenic theory was at its height, he was invited to accompany Doctor Thomas to a neighboring city to see one of these brachial plexus operations. They saw it done and Doctor Ashhurst remarked that if anything could be more barbarous, he had never seen it. He later learned that the result was unfavorable but the surgeon at the same time referred to many cases in which the procedure had been highly successful.

DR. THOMAS A. SHALLOW said that he does not think the operation upon the brachial plexus is a serious or difficult one and believes the results in adults are extremely satisfactory. He added that he had eight cases to show which have almost complete return of function.

## MORTALITY FROM APPENDICITIS

DR. THOMAS J. RYAN, by invitation, read a paper with the above title for which see page 714.

DR. JOHN O. BOWER, by invitation, said that surgeons are most interested naturally in their own mortality. To this end the patients that come directly under the supervision of the individual are given the best he can give. He wished for a moment to speak of the importance of hospital mortality. The mass mortality of the hospital—how many go in with appendices and how many go out—this is important because hospitals as well as individuals have reputations. The figures he wished to give represent the analysis of over a thousand clinical records of patients who had appendicitis. All but a few were operated upon. The analysis of the charts was made by one person assisted by another. The following is a brief summary of the findings:

The factors that influence mortality in appendicitis can be divided into two periods—before and after the patient enters the hospital.

The two factors influencing mortality before the patients enter the hospital are delay and laxatives. At one hospital, where 750 patients were oper-

ated upon, the average time between onset of appendicitis and operation of those who lived was 69 hours; for those who died 151. At another hospital where 252 clinical records were analyzed the average time between onset of appendicitis and operation of those who lived was 90.4 and those who died 157.7 hours; of the 750, 45 per cent. had perforated; of the 252, 46.8 per cent. of the 750, 337 had perforated and 310 or 92.3 per cent. had been given laxatives; of the 252, 118 had perforated and 103 or 87.2 per cent. had been given laxatives; 21 per cent. of the 45 per cent. were cases of general peritonitis. Of the one thousand cases there were 87 deaths—70 per cent. of these had general peritonitis; 93 per cent. or 65 of these had been given laxatives before entering the hospital. Now this is not the surgeon's problem, this is a problem that demands publicity.

In Philadelphia, fortunately, a campaign, sponsored by the Philadelphia County Medical Society, the Department of Public Health and the Philadelphia Association of Retail Druggists, has been instituted to combat this abuse.

The problem that belongs to the surgeon is the problem of the management of general peritonitis. General peritonitis is still responsible for about 78 per cent. of our mortality and the mortality of general peritonitis still varies from 15 to 40 per cent. depending on who operated and when and how. An accurate analysis of the charts of the two hospitals shows that the greatest mortality was at the hands of surgeons who operated immediately on all cases, who did not strictly Ochsnerize his patients post-operatively, who removed appendices in the presence of a spreading peritonitis and who practised the early removal of drains.

DR. EDWARD CROSSAN said that a great deal depends on the attitude of the surgeon in cases of acute appendicitis; while not wishing to minimize the importance of education of the public regarding the danger of the indiscriminate use of cathartics in abdominal pain, he thought that there was something to be said regarding the education of the surgeon. For example, it is a too common practice for some surgeons to allow a case of acute appendicitis to "ride" until it is convenient for the surgeon to operate. This practice is to be condemned. He believes also that there is a tendency on the part of some to rely on drainage alone, leaving the appendix behind. Of course this is sometimes necessary but not as a rule. He attributed the low mortality, 3.5 per cent., in Doctor Ashhurst's service to prompt and adequate surgery. He also wished to ask Doctor Ryan how many cases in his series were not operated upon because he felt they were too sick for any sort of operation.

DR. HUBLEY R. OWEN said that he believed strongly in the necessity for education of the public rather than of the surgeon. In the Philadelphia General Hospital, Doctor Owen's statistics showed a lower mortality than those of any of his colleagues. This was not to be interpreted as meaning that he operated more skillfully but was due to the fact that nearly all of his patients were police or firemen and that these men had been repeatedly cautioned against and were well aware of the danger of taking castor oil, salts and other cathartics for the relief of abdominal pain. When a policeman



or fireman was reported as sick with abdominal pain, a member of the staff was at once sent to see him and if he was found to have appendicitis, he was promptly hospitalized and operated upon.

The speaker also called attention to the pernicious practice of retail druggists' prescribing over the counter for abdominal pain. Such prescriptions were almost invariably for castor oil or citrate of magnesia and many an appendix had perforated as a result of this sort of thing. When Doctor Owen took the matter up with the president of the Philadelphia Retail Druggists' Association, and his remarks were quoted in a pharmaceutical journal he was severely criticized by many druggists who regarded this as an invasion of one of their prerogatives. The speaker added, however, that the Philadelphia druggists had shown every desire to coöperate in the matter.

DR. ASTLEY P. C. ASHHURST reported his recent individual experience with operations for complicated cases of appendicitis (as a sequel to the Table published in the *ANNALS OF SURGERY*, 1927, vol. lxxxv, p. 89):

The only death occurred in a man, forty-five years of age, who was operated on May 25, 1929, the day of admission, for a primary appendicular abscess. Ten days later (June 4, 1929) he was re-operated on for continuing subacute intestinal obstruction, unrelieved by non-operative treatment. He was much improved by this second operation for three days (until June 7, 1929). On June eighth he seemed moribund, and Doctor Ashhurst thought it hopeless to attempt another operation. However, Doctor Crossan was more optimistic, and with Doctor Ashhurst's approval, reopened the abdomen, but found so many kinks involving the entire small bowel, without any strangulation or acute kinking, that nothing could be done; and death occurred about seven hours after this, the third, operation. Both this and the second operation were done under spinal anæsthesia.

Among this recent short series of twenty-eight cases, there were some very ill patients: a *fæcal fistula* developed in the wound in four cases; in all it closed spontaneously in a few days, and all the patients recovered. In fact, this service has come to recognize a *fæcal fistula* as a favorable event in very sick patients, but has not yet attempted a formal cæcostomy at the time of the primary operation.

One case of *gastric tetany* was encountered in this series: A man forty-one years of age was admitted August 23, 1926, suffering for eight days before admission with his second attack of appendicitis. An abscess was drained and the appendix removed on the day of admission. The night following the operation the ward surgeon administered a hypodermic injection of *eserine*, for tympany. This caused in a few hours symptoms of intestinal obstruction, which were relieved by lavage of the stomach and morphine. In a few days the patient developed severe diarrhœa. Eight days after operation he developed acute dilatation of the stomach, with tetany. This was relieved by gastric lavage, hypertonic (15 per cent.) sodium chloride solution intravenously, and an inlying duodenal tube, which was in place for thirty-six hours. After this, recovery was uneventful.

Doctor Ashhurst remarked that *eserine* had been given to this patient

without his knowledge or approval; he regarded it as a dangerous remedy except for simple atonic dilatation of the intestines. In post-operative cases where there may be peritoneal adhesions, he thinks eserine peculiarly dangerous: it rouses so much peristalsis that obstruction scarcely can be avoided. Doctor Ashhurst reminded the Fellows of the Academy of the previous report from his service of a case of gastric tetany, by Dr. Henri De Bayle, now of Nicaragua (ANNALS OF SURGERY, 1925, vol. lxxxi, pp. 622-630).

A third case of special interest was that of a man thirty-one years of age, who had an *incarcerated right inguinal hernia*, complicated by an *appendicular abscess* in the recto-vesical pouch.

Doctor Ashhurst added that it did not seem fair to publish, without qualification, what may be regarded as a selected series of complicated cases of appendicitis, because, as noted in the previous report (1926) on the mortality of appendicitis, he does not himself do most of the emergency operations. He has, therefore, tabulated, below, all the complicated cases of appendicitis admitted to his service (1926-1929), in which the operations have been done by other members of his staff: Doctor Boykin, Doctor Crossan, Doctor Klopp, and in some cases by the Chief Resident Physician for the time being. He desired it to be understood that this larger series is more truly representative of the service of a large hospital, than is his own smaller series. For instance, if the three patients, who were so ill on admission as to make operation not justifiable, were transferred to Doctor Ashhurst's individual list, the general mortality in that series would be above 14 per cent. Yet when these three patients were seen the day after admission by himself, postponement of the operation had been approved by him.

TABLE I  
*Operations for complicated cases of appendicitis*  
(October 1, 1926 to January 1, 1930)  
(Doctor Ashhurst's individual operations)

	Cases	Operations	Deaths	Mortality
Operation on Admission				
Primary Abscess.....	12	12	1	8.5%
Gangrene.....	9	9	0	...
Diffuse Peritonitis.....	6	6	0	...
Total.....	27	27	1	3.7%
Delayed Operation				
Died without operation.....	0	0	0	...
Abscess drained, appendix not removed.....	0	0	0	...
Abscess drained and appendix removed.....	1	1	0	...
Total.....	1	1	0	...
Grand Total.....	28	28	1	3.5%

# PHILADELPHIA ACADEMY OF SURGERY

## TABLE II

*Operations for complicated cases of appendicitis by Doctor Ashhurst's staff,  
at the Episcopal Hospital*

(October 1, 1926 to January 1, 1930)

	Cases	Operations	Deaths	Mortality
Operation on Admission				
Primary Abscess.....	19	19	0	...
Gangrene.....	14	14	2	14 %
Diffuse Peritonitis.....	26	26	4	15 %
Total.....	59	59	6	10 %
Delayed Operation				
Died without operation.....	3	0	3	100 %
Abscess drained, appendix not removed.....	2	2	2	100 %
Abscess drained and appendix removed.....	0	0	0	...
Total.....	5	2	5	100 %
Grand Total.....	64	61	11	17 %

## TABLE III

*All operations for complicated cases of appendicitis in Doctor Ashhurst's service  
at the Episcopal Hospital*

(October 1, 1926 to January 1, 1930)

	Cases	Operations	Deaths	Mortality
Operation on Admission				
Primary Abscess.....	31	31	1	3.2%
Gangrene.....	23	23	2	8.7%
Diffuse Peritonitis.....	32	32	4	12 %
Total.....	86	86	7	8.1%
Delayed Operation				
Died without operation.....	3	0	3	100 %
Abscess drained, appendix not removed.....	2	2	2	100 %
Abscess drained and appendix removed.....	1	1	0	...
Total.....	6	3	5	83 %
Grand Total.....	92	89	12	13 %

DR. THOMAS RYAN said that he regretted that the immediate mortality had been made a matter of discussion. It was not his intention to go into this phase of the question at all. With Doctor Ashhurst, he agrees that it is not of any importance except in the cases requiring drainage. The point that he wished to make was that mortality from appendicitis is on a continuous and progressive increase. In 1895 with a mortality of 20 per cent., fewer people died from the disease than in 1922 with a mortality of 13 per cent. None of the speaker's cases died without operation.

# TRANSACTIONS

## OF THE

# NEW YORK SURGICAL SOCIETY

STATED MEETING HELD FEBRUARY 26, 1930

The President, DR. EDWIN BEER, in the Chair

### SPLENECTOMY FOR MYCOTIC SPLENOMEGALY

DR. PAUL A. DINEEN presented a man, thirty years of age, who entered the hospital July 3, 1929, and was discharged September 7, 1929. At the time of admission he complained of hæmorrhages from the mouth and rectum, swelling of the abdomen and swelling of the feet. The present illness began four and one-half years prior to admission, when the patient suddenly vomited about two quarts of bright red blood. He was otherwise asymptomatic. He was taken to a hospital and stayed there five weeks. There was no more hæmatemesis but he did pass blood by the rectum. Received three transfusions and was discharged much improved. He returned for a blood count in one month and was found to be again anæmic, but was otherwise asymptomatic. Remained one week and received one transfusion. There was no recurrence of bleeding. He then received iron by hypodermic every week for three months. During second admission an enlarged spleen was found. Splenectomy was advised at a later date. Each time he went to the doctor at intervals for a splenectomy he was told that his condition was not good enough to warrant operation. He remained asymptomatic until five weeks ago when he suddenly developed another hæmatemesis and was taken to the hospital. His vomiting ceased shortly after admission and his stools, which were tarry, cleared in three days. He was transfused. One week after admission, he had another hæmatemesis. He was discharged three weeks after admission and other than weakness, was asymptomatic. Patient thought his abdomen had become distended during his stay in the hospital. Before the distention occurred, he was able to feel his spleen. There was also some cedema of the left scrotum and both ankles.

At the time of admission he was a pallid, anæmic-looking man with a large, swollen abdomen. Conjunctivæ were very pale. The tongue was slightly furred. The left lower thorax was bulging and the left costal margin was restrained. There was increased precordial activity. Left border of cardiac dulness was at the anterior axillary line. Right border of cardiac dulness was one centimetre beyond the right sternal border. There was a soft systolic murmur and a split second sound. The lungs were normal. The abdomen was distended markedly with a definite fluid wave. The spleen was greatly enlarged, extending to the left rectus border and to the pelvic brim. The liver was not palpated clinically. The impression at this time was that the patient presented a history and picture of Banti's disease with a marked secondary anæmia and cloudy swelling of the myocardium with hæmic murmurs.

His laboratory findings at this time were:

## SPLENECTOMY FOR MYCOTIC SPLENOMEGALY

	7/3/29	7/10/29	7/15/29	7/17/29	7/19/29
Red Blood Cells.....	2,760,000	4,470,000	3,640,000	4,000,000	4,000,000
Hæmoglobin.....	45%	65%	65%		
Color Index.....	.8				
White Cells.....	3,600	9,900	4,300		
Polymorphonuclears.....	66%	60%	60%		
Lymphocytes.....	22%	40%	40%		
Large Mononuclears.....	6%				
Transitionals.....	6%				

A smear of the blood showed small pale red blood corpuscles with moderate anisocytosis. No poikilocytosis. No malaria parasites. Bleeding time and clotting time were normal. Urine was negative. No blood in stools. Small increased fragility of the blood cells. Blood sugar 109. Blood urea 6 milligrams per 100 cubic centimetres. Wassermann negative.

He was transfused and on July 20 a splenectomy was performed under spinal anæsthesia, supplemented with ethylene. A combined vertical and transverse incision was used. At operation a large, firm spleen was encountered. It was impossible to deliver it into the wound on account of adhesions. The liver was small and nodular, presenting a picture of a typical cirrhosis. Moderate amount of ascitic fluid. The spleen had firm adhesions posteriorly which were difficult to divide. It was possible to deliver the spleen following division of these adhesions. There was a certain amount of oozing along the diaphragm and clamps and packing were applied to this area. The patient was transfused immediately following operation. Six hundred cubic centimetres of blood were given. The day following operation red count was 4,220,000. White cells were 27,000 with 86 per cent. polymorphonuclears. July 22 the red cells were 3,470,000; hæmoglobin 70 per cent. Smear count of white cells was 25,300 with 94 per cent.; large mononuclears 2 per cent.; transitionals 2 per cent.

Prior to operation the man ran a normal temperature for sixteen days. After the operation his temperature slowly increased during next twenty-four hours to 103.2°. It then dropped on the second post-operative day to 100° to 101° and continued along with a gradual rise at times to 103°. During this period the patient had several acute blood crises, the last of which occurred August 21, when his count went down to 1,800,000. He was given a transfusion of 750 cubic centimetres of blood. He had been given one previously August 19, also of 750 cubic centimetres, and it look as though nothing could control the process of blood destruction. At this time it was decided to try neosalvarsan in doses of 45/100 gram because of the presence of a mycelium of fungus found in the spleen and in spite of the fact that the patient had a cirrhosis of the liver. The first dose of neosalvarsan was given August 23. Within thirty-six hours the temperature subsided to normal from 100° and was normal for the remainder of the stay in the hospital. His red counts showed a very gradual but continued rise.

*Pathological Report (Preliminary).*—The specimen consists of a spleen weighing 825 grams and 20 by 11 by 3 centimetres in size in the partially fixed state. The capsule seems to have been thick with some small elevated spots on it. The organ is fairly tense. On section it appears meaty. Fairly firm small yellow masses are found scattered through it, and trabeculæ which are fairly prominent run through it. The rest of the tissue is firm, but spongy. In the basin is also found a blood clot covered on one side by a thin membrane.

Microscopically the malpighian bodies are small. The endothelial cells of the pulp

are increased in number and many polynuclears are present. The nature of the greenish-yellow masses is not apparent as yet.

(Subsequent) *Splenomegaly, splenic fibrosis. Fungus-like inclusion bodies.*—The spleen shows small compact malpighian bodies. The sinuses are rather large and contain many red cells. There seems to be an increase in fibrous tissue between the sinuses. The greenish-yellow masses are made up of jointed strands of yellowish material thought to be mycelium of fungi. The mycelium-like material stains for iron, the tissue just around it even more strongly.

The man has been followed on the outside, coming in for his neosalvarsan injections, at which times he had blood counts. His blood count gradually rose until on October 4 it was 4,600,000 with hæmoglobin of 90 per cent. The most recent count is over 5,200,000 on February 21. He has been at work, feels well and has gained eighteen pounds. He is entirely asymptomatic and feels very strong. It is interesting to note also that subjectively the patient prior to his first neosalvarsan injection felt, as he expressed it, "tired and pepleless" and likewise within thirty-six hours after his first injection in conjunction with his temperature decline and a beginning improvement of his red cells, he stated voluntarily that his feeling of tiredness had completely disappeared.

An article by R. H. Jaffé and L. R. Hill in the *Transactions of the Chicago Pathological Society* (vol. xiii, pp. 35-49) for June, 1928, on "Splenic Mycosis," discourses at length on mycotic diseases of the spleen. The literature is well thumbed and the pathology reviewed in detail.

These large spleens were noted in Algerians and later in Frenchman and a definite splenomegaly, mycotic in character, was demonstrated. The picture is not unlike that of Banti's disease. The rapid and continued recovery in this case after the salvarsan has been very remarkable.

In the article by Jaffé and Hill it was stated that mycosis of the spleen is not uncommon among Algerians and it had been thought that the condition was peculiar to these people. It has been found, however, that there are many cases among the French. The speaker believed them to be more common than had previously been realized. There were technical difficulties in connection with the staining of the specimen that have recently been overcome and a correct diagnosis can now be made more readily. This is probably the reason that there appear to be more.

DR. LAWRENCE W. SMITH (by invitation) said that the pathology in this case was quite unusual. During the past year or so several papers have appeared on the general subject of splenic mycosis, atypical foreign body reactions, etc., etc. This particular case seems to have all the evidence at hand to prove its identity, without the necessity of the pathologist, with the cultivation of the organism by the bacteriologist and the clinical cure following arsphenamine therapy. The Pathological Department of the New York Hospital, however, was able to demonstrate the presence of these mycelial-like structures in the fibrous stroma of the spleen to confirm the story. The reaction appeared to be of a foreign body with the precipitation of a brownish pigment of a ferruginous character. This became deposited on the mycelial strands and on the regional degenerated collagen and elastic tissue fibres as well. It appeared to be composed of iron phosphate, for the

most part, from all the available information at hand. This case is one of a group about which very little is known and one in which a great deal of investigative work should be done.

## PAROTID GLAND ADENO-CARCINOMA IN ABERRANT THYROID TISSUE

DR. SEWARD ERDMAN presented this case because of the unusual histology of the tumor removed from the right parotid gland, and the question as to the origin of the cells. The patient, a man aged forty years, was admitted to the Second Surgical Division of the New York Hospital October 2, 1929, and discharged October 11 on account of a tumor of the right parotid gland which was firm in consistency, deeply fixed, non-tender and with no apparent involvement of nerves, nor skin attachment. He had first noted swelling of the gland two and one-half years ago. Since that time there has been gradual painless enlargement until it is now the size of a large lemon. In cold weather he experiences a dull ache in the auditory canal and throughout the swelling.

*Operation.*—General physical examination negative. Wassermann test negative. At operation, upon exposing the surface of the parotid, no abnormal tissue was seen. After incising the parotid to the depth of one-half inch, there was encountered the glistening, gray surface of a large, sharply demarcated tumor, which seemed to have replaced parotid tissue and which extended by irregular lobulations deep into the maxillary region, passing well behind and onto the mesial aspect of the ascending ramus of the jaw. The internal maxillary artery was thus exposed. The facial nerve was so intimately involved in the growth that it was impossible to avoid injury to it.

The tissue was gristly in consistency, nodular, with a diffuse stroma of dense connective tissue, and was yellowish-white in color.

*Microscopic Examination (by Dr. Lawrence W. Smith)*—Demonstrated an extremely cellular adenocarcinoma, with numerous mitoses. In places definite lumina are found filled with colloid-like material. The cells and the architecture very closely approximate thyroid tissue. The stroma is pseudo-cartilaginous. The tumor is definitely malignant, but is atypical of the usual parotid tumor and might have its origin either in the parotid or in thyroid.

It is now only four and one-half months since operation, but up to the present there is no evidence of recurrence. If the facial paralysis remains too deforming, the use of a fascial strip to raise the drooping angle of the mouth might be considered, at some later date.

DR. LAWRENCE W. SMITH (by invitation) stated that this case presented a very difficult differential diagnostic problem in the laboratory. As has been noted from the clinical history the case did not appear to be quite the usual parotid mixed tumor as it was covered by fairly normal glandular tissue. The material for study consisted of about 5 cubic centimetres of gristly, nodular fragments from the tumor. Grossly, these were not characteristic. The microscopic appearance of the tumor, likewise, was very unusual. As can be seen from the microphotograph (Fig. 1) the cells are relatively low cuboidal in form and arranged in acini of varying size. Many of these are distended and filled with hæmogenous eosin-staining colloid-like material suggesting thyroid tissue. In other areas little secretory activity is noted,



with the acini small and empty. Embedded in the stroma are scattered islands of acinar tissue, which again duplicate the histological picture of thyroid.

These slides have been submitted to several pathologists who concur in the opinion that the microscopic picture is indistinguishable from that of thyroid tissue. Whether it is actually thyroid, or some extremely atypical alveolar development with retention of parotid secretion it is impossible to state positively. Doctor Smith was distinctly of the opinion, however, that this was an aberrant thyroid tumor, although it lacks the usual papillary tendency which aberrant thyroid tissue shows.



FIG. 1.—Tumor of Parotid (Aberrant thyroid tissue).

Embryologically, it is difficult to explain its possible thyroid relationship. As is well known, the thyroid arises from two anlagen, one, the mid-line and principal source of tissue, from the base of the tongue, descending by way of the thyroglossal duct to its final position; the other from the out-pocketing of the posterior portion of the pharynx—the ultimobranchial body—and migrating laterally and downward to fuse with the lateral lobes of the gland. Accordingly, the usual location of aberrant thyroid tissue is along this migratory tract in the neck and should not reach above the angle of the jaw;

but one finds so many anomalous structures in the head region that it seems best to classify this case on the basis of its histology.

#### CYST OF STOMACH WALL (ABERRANT PANCREATIC TISSUE?)

DR. SEWARD ERDMAN presented a woman, nineteen years of age, who in general has enjoyed good health without serious illnesses and no operations except a tonsillectomy in childhood. She has always had some degree of dysmenorrhœa at the menstrual periods.

For the past year, she has had attacks of pain in the right side of the abdomen, usually lasting only a few minutes, and not definitely related to meals, although several times the pain has come on about twenty minutes after her evening meal, and on some occasions she has experienced nausea but has never vomited. The pain at times radiates toward the navel, or at times spreads downward to the pubic region and the right thigh. It is relieved by lying down; following the pain she usually feels nauseated.

Early in January, 1930, she was admitted to the Second Surgical Division of the New York Hospital for observation, which included a gastro-intestinal X-ray series. There was no suggestion of kidney pathology either from the urine examinations nor from the X-rays; nor was there any sugar in the

# CYST OF STOMACH WALL



FIG. 2.—Cyst of stomach wall. X-ray shows filling defect at pylorus.

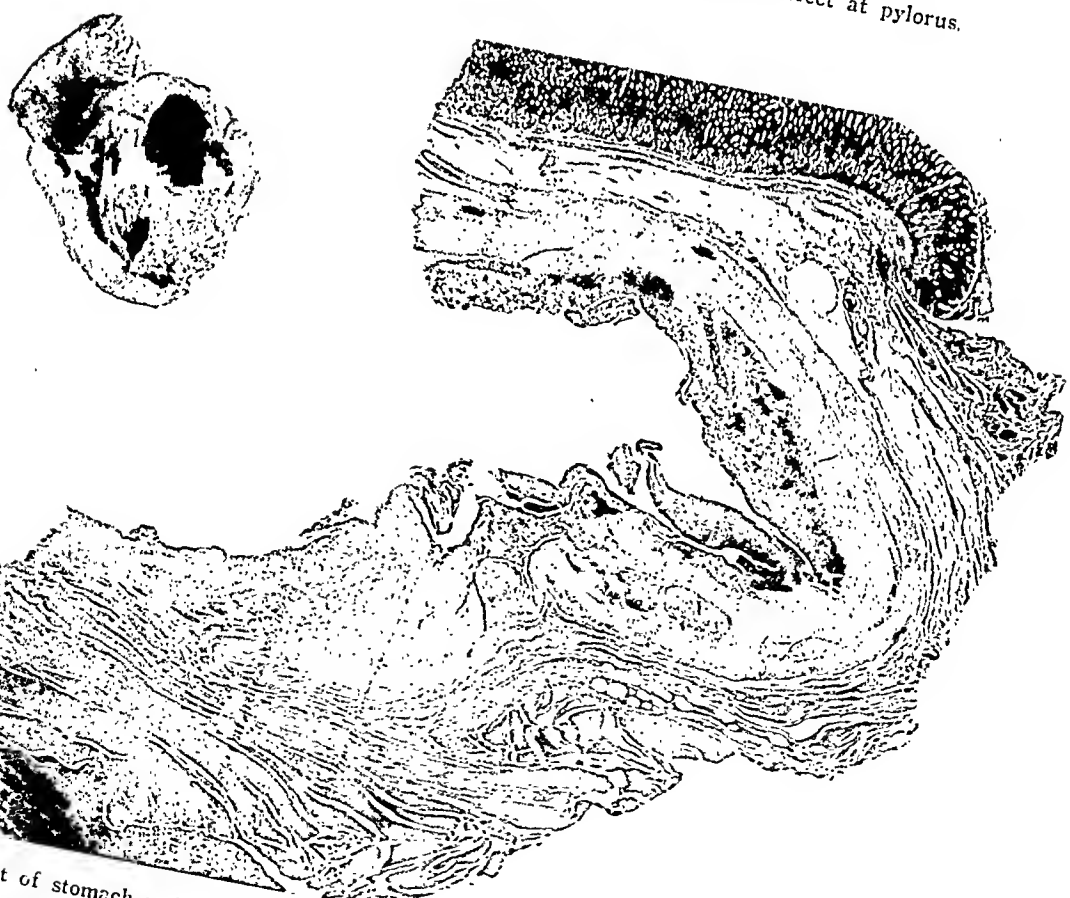


FIG. 3.—Cyst of stomach wall. (Above) Gross specimen. (Below) Microphotograph of cyst.

urine, and the blood sugar was normal. There was no definite abnormality on physical examination, except for slight deep tenderness over the appendix.

The X-ray films of the stomach (Fig. 2) show a definite persistent filling defect on the greater curvature side of the pyloric segment with some suggestion of finger-printing such as is seen in carcinoma, but the absence of corroborative symptoms and the youth of the patient make this diagnosis unlikely. However the picture is that of a tumor of the stomach.

*Operation.*—January 9, 1930, the abdomen was opened through a right rectus incision opposite the umbilicus. The pelvic organs were found normal; the appendix presented no gross lesion or adhesions but was removed.

Palpation and exposure of the stomach revealed a rounded tumor occupying the anterior aspect of the antrum pylori, near the greater curvatures. It was of tense, elastic consistency, smooth, oval outline and the serosa was not adherent over it. It extended to within 2 centimetres of pylorus.

An elliptical vertical incision was made surrounding the prominence of the mass and deepened to the blue wall of the cyst. An attempt to enucleate it did not meet with success and the cyst was penetrated, giving exit to about 40 cubic centimetres of clear watery fluid, and a quantity of brownish gelatinous material. The incision was now carried through the entire thickness of the anterior wall of the stomach, revealing a normal mucous membrane opposite the cyst. The mass was removed, including serosa and mucosa overlying it. The elliptic opening in the stomach was then sutured and the operation completed. The post-operative course was without complication.

DR. LAWRENCE W. SMITH said that this is a distinctly unusual lesion and one which it is difficult to identify positively. It is unquestionably a tumor of embryologic type, which simplifies the problem to some extent, for the recognized tumors of this category in this location are comparatively few in number. The specimen is best described by pointing out its important anatomical structures and relationships by means of photographs. As the specimen was received in the laboratory it consisted of a cystic tumor embedded in the wall of the pyloric end of the stomach. It had been opened and its contents were said to be watery in character. It measured, in its collapsed condition, approximately 2 centimetres in diameter and was roughly spherical in outline. Over the inner aspect of this cystic mass could be seen the gastric mucosa which appeared uninvolved in the process and to be normal in appearance. This is easily seen in the low-power microphotograph. Beneath the plica muscularis is found the wall of the cyst; it is composed of dense connective tissue which merges indefinitely with the somewhat thinned muscular wall of the stomach. The wall of the tumor contains numerous islands of epithelial-like cells which, in places, assume a definite adenomatoid arrangement. In other areas the cells are arranged in irregular masses and stain more intensely. The adenomatoid areas are strongly reminiscent of pancreas, and the feeling of the five or six pathologists, to whom the slides have been submitted, is that the tumor presumably represents aberrant pancreatic tissue which has undergone cystic degeneration. No evidence of extension into the surrounding structure is noted and only rare mitotic figures can be discerned. There is considerable round-cell infiltration in the structure

## THROMBOCYTOPENIC PURPURA

about the cystic mass. The diagnosis, as finally agreed upon, was an embryological cyst of the stomach of aberrant pancreatic origin.

The differential diagnosis in this case was from an enterogenous cyst, a malignant epithelial tumor, or a teratoid tumor, in addition to its probable pancreatic origin. Aberrant pancreatic tissue is recorded in all the textbooks of pathology as being occasionally encountered anywhere along the gastro-intestinal tract, but usually within about six inches above or below the ampulla of Vater. No figures seem to be available for its incidence. The stomach is a much less frequent site, however, for its location and when occurring there is often associated with cystic degeneration. Such aberrant pancreatic tissue rarely contains islands or ducts and accordingly some degree of distention of the acini is not unusual.

DR. CHARLES E. FARR said he had been present when Doctor Erdman operated on this case. At the time, he believed it to be a carcinoma and did not learn until later that it was aberrant pancreatic tissue. In the summer of 1929 he had himself operated upon a young man, about thirty-five years of age, for ulcer of the duodenum and had found a supernumerary pancreas in the upper portion of the jejunum. The duodenal ulcer demanded a posterior gastro-enterostomy but the pancreatic mass, which was about one inch long by three-quarters of an inch wide and one-sixteenth of an inch in thickness, made the short-loop operation impossible. The terminal portion of the duodenum and the upper portion of the jejunum were freed with great care from the fossa of Treitz, thus permitting the resection of the pancreatic tissue. The opening in the intestine was used to perform the usual posterior short-loop gastro-enterostomy. The patient made an uninterrupted recovery and has remained well since.

At the time of operation this pancreatic tissue was considered to be an adenoma but upon further reflection it was called aberrant pancreatic tissue. This was confirmed by the microscopical examination. There was no tumor formation; it was just normal aberrant pancreatic tissue with the usual ducts and islands. Such aberrant pancreatic tissue is not extremely rare; it does, however, at times offer a most embarrassing problem when the tissue has to be excised.

## THROMBOCYTOPENIC PURPURA

DR. SEWARD ERDMAN remarked that essential thrombocytopenia, or idiopathic purpura hæmorrhagica, is a condition about which little is known as to its cause and its pathogenesis. So-called acute cases are those which undergo spontaneous cure after one sharp attack. If the attacks are repeated the case becomes one of chronic idiopathic purpura hæmorrhagica. It usually occurs in childhood or young adult life. The onset is commonly sudden with mild or profuse epistaxis and the appearance of purpuric spots in the skin, and the development of secondary anæmia. The diagnosis is usually made by examination of the blood.

The outstanding features are reduction of number of blood platelets to less than 75,000, or less than one-third of the normal. Coagulation time may be normal or but slightly prolonged. Bleeding time is greatly prolonged.

even up to thirty or sixty minutes or longer. In his case the bleeding time as recorded was only slightly lengthened.

A tourniquet placed about an extremity for five minutes produces petechiæ in the skin below the constriction. The spleen is usually only very slightly enlarged. The effect of splenectomy is immediate and quite spectacular.

He presented a girl, aged sixteen years, who was admitted to the Second Surgical Division of the New York Hospital, January 14, 1929, suffering with a large perinephritic abscess about the left kidney. Her previous history seemed unimportant save for the following facts. Although sixteen years of age, menstruation had not yet occurred. About six months prior to admission she began to have series of "pimples" on her neck. Two months ago she had one moderate nose-bleed and this was repeated two weeks later, but has not recurred. Three weeks ago she began to have pain in the left kidney region with fever, which has persisted. The hæmoglobin on admission was 75 per cent.

January 15, 1929, by incision, he drained a large left perinephritic abscess, containing 200 cubic centimetres of pus which showed staphylococcus aureus on culture. Examination of the surface of the kidney at operation revealed a ruptured cortical kidney abscess. She was discharged, February 2, 1929, with a granulating sinus.

Readmitted to the Medical Service of the New York Hospital February 4, 1929. The day before she had developed severe earache in the left ear, with fever. In the night she had a profuse nose-bleed, and some petechiæ appeared on the feet and hands.

During the next three weeks, no further epistaxis occurred, but the left otitis media developed into an acute mastoiditis.

The blood count February 5 showed red blood corpuscles 1,850,000; hæmoglobin 35 per cent.; white blood cells 16,000; polymorphonuclears 65 per cent. Bleeding time two and one-half minutes; coagulation time seven minutes; platelets 320,000. Blood culture negative.

February 26 a transfusion of 300 cubic centimetres was given.

March 1, 1929, she was transferred to Bellevue Hospital Ear and Throat Division and the next day a mastoidectomy was done. The wound culture showed streptococcus hemolyticus.

June 5, 1929, she was readmitted to the Medical Service of the New York Hospital, with the following interval history.

After the mastoid operation at Bellevue Hospital and a satisfactory convalescence, she was sent to the country (Burke Foundation) for recuperation. In April she was sent home from Burke, because of swollen parotid glands, with the diagnosis of mumps, but the enlarged parotids never subsided and remain quite swollen even now, some nine months later.

Her progress continued fair until May 31, six days before this present readmission, when uncontrollable nose-bleeds set in and many "spots" appeared on her body and extremities.

During the succeeding four and a half weeks, until splenectomy was performed July 8, 1929, the epistaxis and the purpura were practically incessant. No benefit was obtained from repeated packing of the nares, nor from the exhibition of calcium lactate and other preparations.

A total of eight transfusions of 500 cubic centimetres each was administered, the last two transfusions being even larger, *viz.*; 800 cubic centimetres and 750 cubic centimetres respectively. The bleeding, however, was nearly

continuous, there being actually only two intermissions; one which lasted for eight days and the other for a period of three days. At times there was vomiting of blood and tarry stools and the purpuric spots were both large and small. The tourniquet test produced petechiæ. Numerous blood counts and blood cultures were made. The blood cultures were negative except on June 12 when one plate showed staphylococcus aureus, and this was thought to be contamination.

The hæmoglobin ranged from 31 per cent. to 53 per cent.; the red cells averaged about 2,200,000; the bleeding time varied from 5 up to 16 minutes; the coagulation time ran from 4½ minutes down to 1½ minutes. The blood-platelets ran as follows: 56,000—118,000 (at which time the bleeding stopped for eight days) then fell to 28,500 and finally to 28,000.

*Operation.*—July 8, 1929, she was transferred to the surgical wards for splenectomy. Her condition at this time was deemed very critical by both physicians and surgeons and active bleeding was present on this day.

A large transfusion of 800 cubic centimetres was given two hours prior to the operation and another transfusion of 750 cubic centimetres was started during the performance of the splenectomy.

July 8, 1929, a left rectus incision was employed and the spleen found to be but little larger than normal; free from adhesions. Its pedicle was carefully ligated and the organ removed without great difficulty and with practically no loss of blood.

From the moment of removal of the spleen, all bleeding ceased and has not recurred at any time. The convalescence was smooth and the patient was discharged July 26, 1930.

*Follow-up.*—Later blood examination showed that the blood-platelets had returned to a normal count. The patient has gained markedly in weight and is in excellent physical condition. A moderate enlargement of both parotid glands persists but without symptoms.

*Pathological report.*—The spleen as received in the laboratory measured 14 by 8 by 4 centimetres. The malpighian bodies are prominent on section, appearing white against a soft red background. There is some increase in connective tissue. The malpighian bodies show large germinal centres and there is some lymphoid hyperplasia of the sinuses.

Whether this case is to be considered a true case of idiopathic purpura hæmorrhagica with incidental and concomitant severe infections, or whether it may be considered as a case of secondary purpura such as is reported with certain hemolytic streptococcus infections also in agranulocytic angina, and in certain blood dyscrasias such as acute leukæmia and aplastic anæmia, may be a matter for argument.

The clinical story of this case is, however, so intimately tied up with a succession of serious pyogenic infections, and the dramatic cure by splenectomy is so suggestive that we are inclined to the belief that this case rather convincingly suggests that pyogenic infections must be very seriously considered as an important factor in the etiology of thrombocytopenic purpura.

Such frank and severe infections as marked this case will of course be lacking in the history of other cases of this disease, but as most cases occur in children and young adults among whom tonsil infections are so common, it is quite conceivable that even the minor infections may play an etiological rôle.

## RESECTION OF ILEO-CÆCAL JUNCTION FOR CARCINOID TUMOR OF ILEUM

DR. HERMANN FISCHER presented a woman, fifty-nine years of age, who was admitted on November 23, 1929, to the Lenox Hill Hospital with the following history: Was in good health up to three months ago when she began having attacks of pain in the lower and middle portion of the abdomen. The pain was severe and cramplike in character and usually came on an hour after she ate or drank anything. Shortly after the onset of the pain she would feel nauseated and sometimes vomited bitter greenish colored material and at other times just the food she had previously taken. States that her abdomen would become distended during an attack; as soon as she passed gas the distention would disappear and the pain would be relieved. Had been troubled with constipation for years, but during the past two months it had been more severe and she is unable to have a bowel movement without the aid of an enema or a cathartic. During the past month her attacks have been more frequent and she now has them about every fifteen minutes.

Her past history and family history were irrelevant, except that she had a tumor of the back removed fifteen years ago. She was an emaciated, chronically ill-looking woman.

Her lungs presented no abnormalities. Heart not enlarged. In the apical region one hears a soft blowing systolic murmur which is transmitted for a short distance outward and also upward. Sounds are regular, of fair quality. Moderate arteriosclerosis.

Her abdomen was distended, but fairly soft. One palpated distended gurgling large intestinal coils and there is discomfort on pressure over the whole abdomen which is accentuated in the right lower quadrant. There is tympany over the abdomen. In the right lower quadrant one obtains a sense of resistance to the palpating finger but no definite mass can be made out.

November 25, 1929, Dr. P. K. Sauer made a right midrectus lower abdominal incision. Intestines found obstructed at ileo-cæcal junction. Pelvis found filled with irregular hard masses which feel like carcinomatous tissue. So many adhesions were present that it was impossible to distinguish the point of origin of the carcinoma without extensive dissection. A loop of ileum near ileo-colic junction was therefore brought out through the abdominal wound, and an ileostomy was performed. A Paul's tube was fastened into the gut and the abdomen closed around it by layer sutures. The patient made a good recovery after this operation and was relieved of her obstruction. After several weeks her general condition had so much improved that it was thought safe to try to relieve her of the cause of her obstruction.

December 28, 1929, she was again operated upon by Dr. H. Fischer. Incision through previous scar. Pelvic adhesions present at previous operation were first explored. These were seen to be secondary to small multiple calcified fibroids of the uterus and were not in any way causing the intestinal obstruction. The ileo-cæcal region was now explored and a mass felt in the cæcum, practically located at the ileo-cæcal junction, completely occluding the terminal ileum at that point. Liver smooth, no evidence of metastasis. A resection of the lower ileum, the cæcum and part of the ascending colon was done. An end-to-end anastomosis was used to reconstruct the continuity of the bowel. The patient made a good recovery and has been feeling well since. The pathological examination of the specimen shows the following: The wall of the terminal ileum is thickened and at its junction to the cæcum is constricted by a mass which replaces the wall. On opening the lumen of the gut, this mass is seen to be annular in type and to completely occlude the lumen of the cæcum. The tumor mass is 3.4 centimetres wide, is hard,

fibrous and firmly attached to the tissues of the wall. On the mucosa, the dividing line between tumor and relatively normal mucosa is sharp, but in the deeper layers the tumor is continuous with the wall of the gut. The ileo-caecal valve is pendulous and hangs in the lumen of the caecum.

*Microscopical examination* of sections obtained from one part of the tumor shows an epithelial growth composed of small, deeply stained polyhedral cells with vesicular nuclei and scanty protoplasm. These cells are usually disposed in solid masses of various sizes, some of which are very irregular. The epithelium shows a tendency to retract from the stroma. Some of the cell masses enclose small lumen-like spaces, and in one part of the tumor are a few small, well defined acini lined with cuboidal epithelium. The stroma varies in amount, though it is mostly rather scanty and dense and acellular. The tumor deeply infiltrates the gut wall and in many places the epithelium rests directly upon the smooth muscle.

The tumor is of the type of the so-called carcinoids, which not infrequently are found in the appendix. There are metastases in several of the lymph glands.

DR. SEWARD ERDMAN considered the occurrence of carcinoid tumors of the appendix to be not uncommon as he thought that a small percentage of all cases of chronic appendicitis would show a small carcinoid within the appendix. Ten years ago he operated on a young woman who had presented marked symptoms of acute intestinal obstruction in the lower ileum. Resection at the site of the obstruction disclosed a carcinoid tumor of the ileum which almost completely obstructed it. There were no enlarged nodes. The patient had not been in good health even after the operation; a year ago she was in the Battle Creek Sanitarium and was now in the Massachusetts General Hospital for treatment for marked anemia and continuous loss of weight. The cause for this condition had not been diagnosed. Her chief complaint is weakness. Two years ago Doctor Lahey, of Boston, performed a hysterectomy for fibroids. Having been informed of her previous operation, on opening the abdomen he examined the anastomosis site carefully and could see no sign of recurrence. It is probable that the cause of her present ill health will not now be diagnosed before autopsy which might possibly reveal some manifestation of carcinoid recurrence.

DR. FISCHER in closing the discussion said that these carcinoids do not often metastasize, but in this case there were very distinct metastases in the mesenteric glands of the caecum. The pathology was much the same as that found in carcinoids of the vermiform appendix.

## RESECTION OF STOMACH FOR ULCER

DR. HERMANN FISCHER presented a man, aged sixty-seven years, who was admitted to the Lenox Hill Hospital December 19, 1929, with the history that he had been in fairly good health until two months ago when he began having a heavy feeling of distention in the epigastric region. This came on at irregular periods after meals and was accompanied by gaseous and sour eructations. No pain, nausea and vomiting. About the same time he began to lose his appetite. His bowels have been regular and he has never noticed blood in his stool. No loss in weight. A week ago he began having hiccoughs shortly after the taking of food; at first they would last from two to three hours, but for the past two days he had them constantly. Past and



family history negative. He had lost a leg through an accident. He was an elderly, fairly healthy looking man. Teeth poor, tongue coated. Lungs: Diminished resonance at both apices, but no râles. Dulness at both bases with occasional moist small râles. Heart: sounds regular, normal in rate and very soft, poor in quality. Pulse is regular, fair tension, moderate arteriosclerosis. Abdomen obese and flaccid. Double inguinal hernia, easily reducible. The liver is felt one and one-half finger's breadth below costal margin, smooth and not tender. The spleen is not felt. No abnormal masses, tenderness or rigidity. Left leg is amputated in the middle third of femur. Urine contains albumin, occasional hyaline cast. Blood count: 4,850,000 red cells; hæmoglobin 88 per cent.; leucocytes 11,800. Stomach contents: P. C. free acid 14; tot. acid. 31; blood + +. X-ray examination: There is noted a moderate-sized gastric ulcer crater in the midportion of the lesser curvature. There is also a constricting lesion of the pylorus producing a canal about one inch in length. From the röntgen appearance there would be suspicions of malignancy involving the pyloric region accompanying the gastric ulcer.

*Operation* January 6, 1930.—Mid-line incision from ensiform cartilage to umbilicus. On opening the peritoneal cavity an indurated, hard, irregular mass was felt and seen about midway between pylorus and cardia of the stomach at the lesser curvature. As a strong suspicion existed for the possibility of a carcinoma a subtotal gastrectomy after Billroth I was done. There was no evidence of glandular or hepatic metastasis. The pathological examination proved the lesion to be an ulcer. The patient made an uneventful recovery and feels well today.

#### RESECTION OF CARCINOMA OF THE TRANSVERSE COLON

DR. A. HYMAN presented a man, thirty-five years of age, who was admitted to Mount Sinai Hospital October 25, 1929, with the history that one year ago he had dull pain in left lumbar region radiating anteriorly, lasting about fifteen minutes. No urinary symptoms. Three months ago there was a second similar attack, followed by hæmaturia. Cystoscopy and X-ray were negative. Since then he has had rather constant low-grade pain in the left lumbar region.

Two months after the onset of this condition cystoscopy and X-ray showed a small stone in the left kidney. Following this he was well except for occasional dull pain in the left lumbar region until five months later (two and one-half months ago), when he had a very severe dull pain in the left lumbar region lasting six hours. With this attack he had frequency and hæmaturia. Two weeks afterwards he passed two small calculi. X-ray and cystoscopy following this were negative.

His present illness began four months ago with general abdominal cramps occurring daily, unassociated with meals. There was no nausea or vomiting. Bowels fairly regular; no melæna.

Two months ago he felt a small mass in the lower left quadrant of the abdomen, sausage-shaped, freely movable and two to three inches in length. His appetite had been good, and he had lost only a few pounds in weight. When admitted he was very pale, although fairly well nourished. Heart and lungs were negative. A freely movable, round mass about the size of a golf ball was palpated in the lower left quadrant of the abdomen. This mass could be felt on some occasions, and was absent on others. Rectal examination was negative, as were cystoscopy and X-ray. The urinalysis was normal. The hæmoglobin was 70 per cent, polynuclears 80 per cent, and 10,000 white blood cells were found; the blood urea showed 12 milligrams per 100 cubic centimetres. The Wassermann was negative. A barium enema showed the colon to fill readily to about the mid-transverse colon, where an area of nar-

## SUPPURATIVE RETROPERITONEAL PELVIC LYMPHADENITIS

rowing was encountered. There was no obstruction or delay, however, at this point.

October 25.—*Operation*, under gas and oxygen—Resection of transverse colon with side-to-side Murphy button anastomosis. Cæcostomy for carcinoma of the transverse colon. Six-inch left transrectus incision. Findings.—Tumor the size of a tennis ball covered over with omentum and exudate in midportion of transverse colon. The growth was not adherent to the surrounding structures. Resection of growth using Payer clamps. It was found that after resection a suture anastomosis would be under tension unless the gut was mobilized freely on either side, and a large Murphy button side-to-side anastomosis was accordingly done. Considerable glandular involvement was found in the mesentery. A Witzel cæcostomy was then done through a McBurney incision.

The post-operative course was remarkably easy. There was only slight distention and vomiting on several occasions. Flatus was expelled on the fifth day. On the eighth day there were fluid bowel movements. The cæcostomy tube was removed on the ninth day, as drainage had practically ceased. There was never any fecal discharge from the site of the anastomosis. There was slight infection of the main incision, which cleared up rapidly. The patient was discharged from the hospital with both incisions almost healed.

November 17, twenty-three days following operation, he was having formed bowel movements daily. The button was not passed until the 19th of January. He was not able to pass the button himself, but it was readily removed by grasping it with the forceps.

The pathological examination of the specimen was reported as "Carcinoma with perforation into the omentum and abscess formation." The lymph nodes were not involved.

## SUPPURATIVE RETROPERITONEAL PELVIC LYMPHADENITIS

DR. A. HYMAN read a paper with the above title for which see page 718.

DR. CARL G. BURDICK referred to a case observed by him in Bellevue Hospital. The patient was a woman twenty-seven years of age, who had been admitted to the hospital in December complaining of a pain in her left groin, which radiated down her thigh. Her temperature rate varied from 101° to 103°. There were some glands palpable in the left femoral region. Pelvic examination revealed a mass in the true pelvis. X-ray of the sacroiliac synchondrosis was negative. A diagnosis of retroperitoneal lymphadenitis was made and she was treated with hot douches for ten days. The mass gradually increased in size until it extended up into the iliac fossa. The abscess was incised through an incision parallel to Poupart's ligament and two or three ounces of pus evacuated. Her condition improved but at the end of seven or eight days her discharge became bloody. It was, however, learned that she was menstruating. After five days her discharge again became purulent. She made a satisfactory recovery and was ready to go home when she started to menstruate again and had a bloody discharge from her wound. Pelvic examination was negative. Lipiodol injection of the uterus and tubes and a second injection of the sinus failed to reveal any communication between them. Menstruation ceased and the discharge became purulent again. She was discharged from the hospital a few days later.

# BRIEF COMMUNICATIONS

## TUBERCULOMA OF THE DESCENDING COLON

### CHRONIC HYPERPLASTIC TUBERCULOSIS

TUBERCULOMA is a term now being generally used for the condition commonly known as chronic hyperplastic tuberculosis. It being exceedingly rare in the left half of the colon, the report of the following case is considered worth while.

A man, white, age twenty-two years, single, was first seen by the writer June 1, 1926. At this time he stated that he had been in his usual good health up to seven or eight months previously when he began to lose weight and strength and to suffer from "indigestion." His appetite gradually became very poor. He became more and more constipated and had frequent attacks of generalized colicky abdominal pain, most marked as a rule in the left half of the abdomen. His condition has grown progressively worse and he has lost about thirty pounds in weight and has lost markedly in strength. For the past two months he has had attacks of abdominal pain daily. The pain is sharp, of two or three minutes' duration, and always precedes defecation, and as a rule is relieved immediately thereafter. For the past two or three months has complained of considerable bloating and belching. At no time did he notice any blood in his stools.

Previous to his present illness he had been very rugged and well and was very prominent and active in athletic circles. He has had the usual diseases of childhood. He has never had any chronic cough, night sweats, palpitation, etc. His mother, father, and two sisters and two brothers are living and well. There is no family history of carcinoma or tuberculosis. The man himself is undernourished and appears chronically ill, pallor being quite marked. Physical examination negative for head and chest, except a chronic infection of the tonsils. Pulse, 90; temperature, 99.5°; respiration, 18.

The abdomen is scaphoid, of symmetrical contour throughout; no signs of fluid present; moderate tenderness and rigidity present in the left lower quadrant; about two inches internal to the left anterior superior iliac spine, palpation reveals a round, hard, sausage-shaped tumor about two inches in length, which is tender to touch and seems quite fixed in position, occupying the region of the left colon. The spleen and liver are not palpable.

*X-ray examination of the gastro-intestinal tract:* Negative, with the exception that a large barium clump is present in the ascending and transverse colon for a considerably longer time than normal.

*Blood examination.*—June 6, 1926: hemoglobin, 75 per cent.; red blood cells, 4,000,000; white blood cells, 22,900; polymorphonuclears, 79 per cent.; small mononuclears, 15 per cent.; large mononuclears, 6 per cent.; blood Wassermann: negative.

*Urinalysis:* specific gravity, 1.008; amber color; reaction acid; albumin: negative; sugar: negative; microscopic examination of the urine shows a small amount of debris present.

June 9, 1926, the patient entered the hospital for further observation. *X-ray report* after a barium enema given June 19: "Narrowing of colon for six inches above the sigmoid, the barium shadow being only about a finger's breadth in width in this portion. X-ray diagnosis: Neoplasm of colon."

From the time of patient's admission to the hospital June 9, 1926, up to June 19, 1926, he had a daily evening rise of temperature to 99° and 99.5°.

## TUBERCULOMA OF DESCENDING COLON

*Operation* June 19, 1926. Gas-ether anaesthesia.—Abdomen opened through a left rectus incision extending from the level of the umbilicus to just above the pubic bone. A small amount of clear fluid was present in the lower part of the abdominal cavity. The whole length of the descending colon from the splenic flexure to the sigmoid was involved in what was apparently a chronic hyperplastic tuberculosis (Fig. 1). The peritoneum was markedly congested and covered with tuberculous granulation material. The walls of the colon throughout its entire length were markedly thickened and very hard, which condition caused a marked encroachment upon the lumen of the bowel, incomplete intestinal obstruction resulting. There was moderate thickening of the splenic flexure and the first inch or so of the sigmoid. The descending meso-colon was markedly contracted and thickened which resulted in the colon being firmly fixed in position, immovable and retracted posteriorly to a marked extent. Numerous enlarged glands of various sizes were present in the meso-colon and along the blood-vessels running to the colon. The sigmoid colon proper was quite normal as was the entire remainder of the gastro-intestinal tract, no other evidences of tuberculosis being present.

The gall-bladder was normal in size; its contents were easily expressed. Both kidneys were apparently normal in size, shape and position. Two glandular masses at the base of the wall of the colon were excised for biopsy. Resection of the involved portion of the colon not being considered feasible, an isoperistaltic anastomosis was performed between a loop of the ileum about eighteen inches from the caecum and the sigmoid colon, after which a cigarette drain was inserted in the lower part of the pelvis and the abdomen closed in layers.

The patient remained in the hospital for ten days following the operation, the abdominal wound healing by primary union. The post-operative course was uneventful with the exception that beginning on the fourth day, the patient began to have frequent defecations throughout the day and night, these continuing during the remainder of his stay in the hospital, some relief being obtained from the administration of opiates and astringents.

The pathological report of the tissue excised at operation is as follows: "Specimen: Lymph glands. The specimen consists of two small pieces of tissue, glandular in type. Two sections are taken to be prepared for microscopic study.

*"Microscopic examination.*—The tissue is lymph gland showing early tuberculous formation with giant cells in typical epithelial cell arrangement around the periphery of the lesion. The tubercles are found in the two sections examined.

*"Diagnosis.*—Early stage of tuberculous infection of lymph glands."

For the first six or eight weeks following the patient's discharge from the hospital, his condition seemed satisfactory, in many respects, in that he appeared and acted better than for some time previously, although the frequent defecations or diarrhoea were never entirely controlled. After the first few weeks of apparent improvement, however, he started to fail. The diarrhoea persisted. His appetite became very poor and he gradually lost in weight and strength.

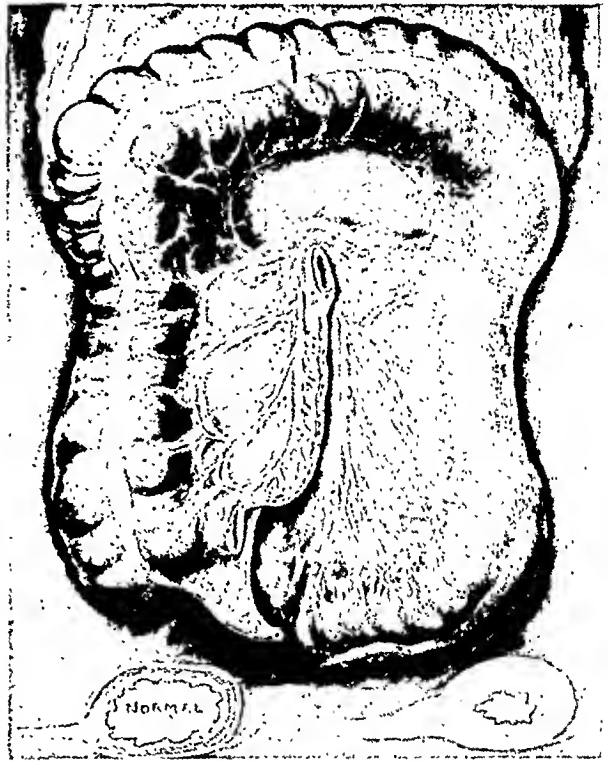


FIG. 1.—Tuberculoma of the descending colon.

After being in attendance about five months, post-operatively, the writer was dismissed from the case.

At no time during the pre-operative or post-operative course of the case was there any manifestation of tuberculosis elsewhere in the body.

Following my discharge I ascertained that the patient continued to fail progressively and death occurred about ten months after I operated upon him.

*Comment.*—Tuberculosis of the intestine, according to one classification occurs in four types:

1. Ulcerating or tuberculous enteritis. It may be primary in children but in adults is secondary to pulmonary tuberculosis. It is stated by some authorities that this type occurs in 50 per cent. of the patients who died of pulmonary tuberculosis.

2. Cicatricial or stenosing type resulting from healing or annular ulceration of the bowel.

3. The entero-peritoneal type, characterized by an ulcerating, caseating lesion of the ileocæcal segment with a marked tendency to softening and suppuration. External fistula is common in this type.

4. Chronic hyperplastic tuberculosis, characterized by variable but considerable hyperplastic annual thickening of the wall of the bowel. This type was first described by Hartmann and Pilliet in 1899. It usually affects the ileocæcal region, producing an ileocæcal tumor. Occasionally the rectum is involved; less commonly the ileum, together with the cæcum. Involvement of the ileum alone is almost never seen, only eight cases having been reported in the literature. It is a disease of long duration and the lesion is characterized by extensive formation of fibrous and tuberculous granulation material. The submucosa in these cases is greatly thickened by fibroblastic hyperplasia and by lymphoid cells. In the muscle layer there is marked hypertrophy of the muscle bundles which are separated and in places destroyed by aggregations of lymphoid and epithelioid cells.

This variety of tuberculosis is considered a primary lesion in a high percentage of cases both because of the inability to demonstrate tuberculous infection elsewhere, even at autopsy, and because of the cure by extirpation of the local lesion. Occasionally, however, tuberculosis elsewhere will be demonstrable as a coëxisting lesion with hyperplastic bowel tuberculosis.

The exact reason for the appearance of tuberculosis, particularly in the ileocæcal coil, is explained variously by different observers. Stagnation and fermentation unquestionably take place in the cæcum and the organisms undoubtedly lose some of their virulence upon reaching this portion of the intestinal canal, infection resulting from a combination of these factors.

Calmette believes that the infection takes place through the circulation, the bacilli passing through the mucous membranes of the bowel without injury to it and lodging in the regional lymphatics, the pathological reaction producing scar tissue and not ulceration, with a resultant tumor formation. This latter explanation seems most satisfactory to the majority of writers.

The disease occurs by far the most often in comparatively young individuals and particularly in male subjects.

In a treatise on "Tumors of the Rectum and Colon," published as late as 1925, no mention is made of this condition. Dr. W. J. Mayo states that he believes these cases were more common in the early days when many opportunities were afforded for infection from bovine tuberculosis and that it was not possible to remove the menace from milk until it was found that hogs were infected with tuberculosis from the milk—and then of course something had to be done about it.

The treatment of these cases is surgical. If possible, resection of the involved segment should be done; otherwise an entero-anastomosis between the proximal and distal parts of bowel wall beyond the diseased area.

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#### CONGENITAL ABSENCE OF THE GALL-BLADDER IN MAN\*

CONGENITAL absence of the gall-bladder in man is a rare occurrence. Bower<sup>1</sup> (1928) collected sixty cases from the literature (one case from a double liver; thirteen cases of absence of the gall-bladder and all the ducts; fifteen cases of absence of the gall-bladder, common and cystic ducts, including his own case; thirty-one cases of absence of the gall-bladder and cystic duct). Knox<sup>2</sup> reported two instances in 2000 autopsies; Mentzer<sup>3</sup> and Nagel one in 1600 autopsies. Schaeffer<sup>4</sup> has seen this condition once in approximately 3000 dissections, the case here reported.

If no gall-bladder is found at operation or autopsy one of three conditions is possible: First, the gall-bladder may have been removed at a previous operation; however, the history and the physical examination of the patient should preclude this possibility.

Second, the gall-bladder may be buried in the liver, the so-called intra-hepatic gall-bladder. In such instances cholecystography should be of value. Lintz<sup>5</sup> reported a case in which tetrabromophthalein was administered to a patient and failed to outline a gall-bladder, which at operation was proven to

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\* From the Laboratories of the Daniel Baugh Institute of Anatomy, Jefferson Medical College, Philadelphia.

be congenitally absent. Lemon<sup>6</sup> found and removed two stones from an intrahepatic gall-bladder.

Third, the gall-bladder may be congenitally absent.

This report records an instance of congenital absence of the gall-bladder and the cystic duct, found in a cadaver during routine dissection.

*Clinical History*—J. R., a white male, fifty-seven years old, was admitted to ..... Hospital, May 25, 1927, with the diagnosis of chronic active fibroid pulmonary tuberculosis, chronic fibrous pleurisy and chronic myocarditis. The patient stated that "his stomach had never been strong"; that he was subject to constipation and attacks of nausea and vomiting without jaundice; and that no operations had ever been performed



FIG. 1.—Photograph of the Liver specimen. a Caudate lobe b Left lobe c Hepatic artery d. Quadrate lobe. e Round ligament f. Inferior vena cava g Right lobe h Portal vein i Common bile duct. k. Usual site of the gall bladder.

Physical examination revealed a well-developed adult, 5 feet 6 inches in height, weighing 150 pounds. The chest showed the signs of active tuberculosis. The abdominal examination recorded some rigidity of the muscles and slight tenderness over the gall-bladder region. No scars or palpable masses were found. Death occurred May 2, 1928.

*Description of the Liver.*—Careful post-mortem examination of the abdominal wall and related structures proved conclusively that no operation had been performed.

Upon opening the peritoneal cavity, the liver appeared normal as to size, shape and anatomical relations. The right lobe measured 17 centimetres, the left lobe 11 centimetres, the caudate lobe 4 by 6 centimetres, and the quadrate lobe 3 by 5 centimetres. The gall-bladder and the cystic duct were absent, the usual site of the gall-bladder fossa being a convexity (Fig. 1). The capsule and peritoneum over this region were intact and microscopically wholly devoid of any gall-bladder tissue. The common bile duct which drained the biliary system of the liver (in a sense that was no common duct in view

of the absence of the cystic duct) was 9 centimetres long and 8 millimetres wide, with the normal relations, namely, to the right of the hepatic artery and ventral to both the hepatic artery and the portal vein. The channel representing the common duct received the pancreatic duct 1 centimetre from the duodenal papilla (ampulla of Vater).

*Technic Employed in Excluding an Intra-Hepatic Gall-Bladder.*—In order to exclude the possibility of an intrahepatic gall-bladder the liver was injected through the common duct with lipiodol and X-rayed.

The common bile duct was exposed from the portal fissure to the duodenal papilla, by dissecting it free from the lesser omentum, the pancreas and the duodenal wall. Having thus identified the duct, a cannula was securely tied in a slit in the lumen 1 centimetre from the liver, so that the pressure necessary to force the oil into the finer bile ducts of the formalin-hardened specimen would not rupture the common duct and spread the opaque material over the liver surface. An injection-syringe with 2 cubic centimetres of lipiodol (Lafay) was then attached to the cannula and the preparation placed



FIG. 2.—X-ray plate of the injected liver. The intra-hepatic bile ducts as outlined by the lipiodol have been traced over with India ink. Note the absence of any accumulation of the opaque mass, proving that the gall-bladder is not buried in the liver substance.

on the fluoroscopic table. Using considerable hand pressure,  $1\frac{1}{2}$  cubic centimetres of lipiodol was injected into the common bile duct, controlling the spread of the oil into the finer bile ducts under the fluoroscopic screen. X-ray plates of the injected liver with the cannula in place were taken by Dr. J. T. Farrell, Jr.

Examination of the X-ray plate taken at the conclusion of the injection (Fig. 2) shows the right and left intrahepatic bile ducts and their ramifications clearly outlined. There is no collection or massing of the oil at any point within the liver as would occur if the gall-bladder occupied an intrahepatic position.

This case proves therefore to be one of congenital absence of the gall-bladder and cystic duct in man, as determined by the history of the patient, the gross examination of the liver and the intrahepatic injection of the bile ducts with lipiodol, and the X-ray plates.

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## PLASTIC REPAIR OF PARTIAL LOSSES OF THE NASAL TIP

PLASTIC repair of partial loss of the nasal tip is beset with many difficulties. In the first place, the loss is not extensive enough to warrant the



FIG 1—Partial loss of nasal tip



FIG 2—Final result secured by the graft

swinging of a forehead flap, which always leaves a permanent scar, and, in most instances, if used would be too thick to produce the finest result. Free grafting is impracticable because of the inability to get the satisfactory pressure necessary for a full-thickness graft; and the Thiersch graft, even though it might take, would not have body enough to produce the desired cosmetic result. Hence, we are called upon to repair these defects in another way, by using pedicle flaps, two from the arm and one from the neck.

The following cases are presented in an endeavor to show a simple and certain method of dealing with small losses of the nasal tip, without mutilating the forehead.

# REPAIR OF THE NASAL TIP



FIG. 3.—Tube pedicle graft from arm in process of formation.



FIG. 4.—Tube pedicle graft approximated to face and sutured to refreshed nasal tip.



FIG. 5.—Pedicle tube graft taken from neck.



FIG. 6.—Final result obtained in the case shown in Fig. 5.

CASE I.—Fig. 1 is a case of partial loss of the nasal tip due to a bite. Repair was attempted several times by the use of free grafts, and in each instance failure resulted because of the inability to maintain sufficient, firm, and even pressure. A tube pedicle graft from the inner aspect of the left arm was decided upon because of its easy accessibility, similarity of color and texture, and freedom from hair. A tube was made which can be seen in Fig. 2 and after a ten-day interval it was transplanted to the nose. The arm end was severed at the end of four days and utilized to make up the columellar loss. Fig. 3 shows method of fixation while the tube is attached to the nose. The time generally allowed for a transplant to attach itself firmly is about ten days but in this case due to the highly nervous state of the patient it was released sooner without harmful result. Fig. 2 shows the final result.

CASE II presented a partial loss of the nasal tip due to the previous removal of an angioma. The procedure in this case was an exact duplication of that reported in Case I with the exception that no free grafts were attempted and ten days were allowed for the transplant to fix itself firmly before severing the arm pedicle. The final result was equal to that obtained in the preceding case.

CASE III shows a loss of the right ala following excision of a basal carcinoma by diathermy, one year being allowed before repair was attempted to make certain there was no recurrence. In this case an arm graft was deemed inadvisable because the patient had been an outdoor worker for years and the skin of the face was so hardened and tanned that it did not match the arm skin. As can be seen in the picture (Fig. 5), a tube pedicle graft was taken from the neck. Except for the source of the skin the technic was the same as in Case I. Fig. 6 shows final result.

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## BOOK REVIEWS

I. SURGICAL DIAGNOSIS. By AMERICAN AUTHORS. Edited by EVARTS A. GRAHAM, M.D. 3 octavo volumes; 2,750 pages; separate index volume. Philadelphia, W. B. Saunders Co., 1930.

II. DEMONSTRATIONS OF PHYSICAL SIGNS IN CLINICAL SURGERY. By HAMILTON BAILEY, F.R.C.S., Eng. 2nd edition, octavo; cloth; pages 268. New York, Wm. Wood & Co., 1930.

I. THE changing conditions in the field of surgery that the present generation has witnessed are well illustrated by Graham's three-volume book in which forty-two American surgeons have coöperated. As one looks over the list of contributors to this work, one is impressed with the fact that here is a list composed from the new generation which has come upon the American surgical stage since the appearance in 1892 of the coöperative American Text-book of Surgery edited by Keen and White. The preface to the original edition of that American Text-book bears the date of August 1, 1892, nearly thirty-eight years ago—more than a generation. The senior editor of the book, the venerable Dr. William W. Keen, is still living and actively interested in the progress of surgery; all the other authors, with the exception of the writer alone, have passed away.

Diagnosis was not overlooked by the writers in that volume. Since that time diagnosis has engaged repeatedly the special attention of various writers. The earlier books of Kiliani, A. B. Johnson and Eisendrath have not been forgotten. DeQuervain and Donhauser are still quite up to date. It is now ten years since, under the leadership of the lamented Albert J. Ochsner, a large four-volume treatise on Surgical Diagnosis and Treatment was put forth by American authors. The contributors to that treatise included seventy-five of the active surgical workers of that day in America. The changes which a few years may bring about are well illustrated in the fact that not one of these names of men who were our authorities in surgical diagnosis ten years ago appears in the list of the forty-two men who are assembled as the authorities in the present book.

The recent volumes devoted to Surgical Diagnosis from the pens of thirty-one British surgeons, edited by Walton, of the London Hospital, are still fresh from the press. Such an appreciation of the importance of the subject as these rapidly successive and bulky volumes indicate is unmistakable. Diagnosis is at the very root of successful practice, in surgery even more than in internal medicine, which latter, in larger proportion than in surgery, may be relied on for spontaneous cure however mistaken may have been the diagnosis and misdirected the treatment.

11. In sharp contrast with the more elaborate books above mentioned, is this book of Bailey which limits itself to the description of those physical signs which may be of use in the diagnosis of surgical conditions. To accomplish this, the author has assembled an extensive group of illustrations, 306 in number to be accurate, to each of which is attached a certain amount of explanatory text, brief and aphorismic in character. It is quite evident that the idea of the book originally was that of a hand-book for the use of the medical student. For the best use of the book, it is, however, undeniable that considerable more of clinical training and experience must have been enjoyed by any one who expects to get the full benefit of it than could be expected from even a fourth-year medical student. There is no one, however, who has to do with surgical conditions who would not derive benefit from its pages.

The two works, the more extensive system edited by Graham and the axiomatic compend with its mass of illustrations prepared by Bailey, supplement one another admirably.

The Graham system presents a series of elaborate monographs admirably stating the teaching of the present day. It is a valuable book of reference in which the practical surgeon will find a mine of well-ordered information in whatever department of surgical diagnosis he may desire help. The tone of scholarly accuracy and of completeness of scope in the treatment of special conditions calls for high commendation.

LEWIS S. PILCHER

OTOLOGIC SURGERY. By SAMUEL J. KOPETZKY. 8vo. Cloth. Publishers, Paul B. Hoeber, Inc., New York, 1929.

The second edition of Doctor Kopetzky's *Otologic Surgery* offers the author a great opportunity not only to bring the subject of otologic surgery up-to-date but also serves to elucidate some of the subject matter which, in the first edition of four years ago, was of necessity not completely conclusive. The classification of middle-ear diseases based on pathogenesis is a distinct advance over the previous classification. The first edition classified the middle-ear diseases in accordance with their clinical aspect. Very obviously this not only limits the classification to two general classes but fails to give an adequate picture of the various types of pathology. The new edition presents a very complete classification and illustrates very clearly the decided advantages of basing all diseases on their pathology. This basis, once accepted, presents a common ground for study as well as an accurate indication for treatment.

The chapter on "The Surgery of the Labyrinth" is so superior to the previous chapter on this subject as to alone justify the author in the publication of the new edition. "Pathogenesis of Suppurative Labyrinthitis" is new and well illustrated. "Classification of Purulent Labyrinthitis" is also

## BOOK REVIEWS

new and very welcome. The physiological note and "General Remarks Concerning the Labyrinth Tests" are an addition that should be particularly well received. This is one of the most comprehensive and altogether noteworthy contributions on this phase of labyrinth diseases which has been written. The few pages devoted to this subject will merit careful study.

Otitic sepsis is always a serious problem and Doctor Kopetzky in the chapter devoted to this subject has brought to his discussion of the diagnosis, the pathology and the treatment a large experience and his deductions are worth serious attention. In this particular phase of otology it is well worth noting the transition from an accepted pessimism of a few years ago to the attitude of optimism resulting from the putting into practice of certain measures which have now become well authenticated in the treatment of otitic sepsis.

Chapter IX deals with "The Surgery of the Meninges." The classification on a pathologic basis is a distinct advance and lends itself to a more accurate study of the surgical indications. "The Summary of the Characteristics of the Spinal Fluid in the Various Types of Meningitis" is a most acceptable new contribution. Several illustrations have been added.

The chapter on "The Surgery of Otitic Brain Abscess" contains several features that are most acceptable. The illustrations are more numerous and very illuminating. This chapter has been brought up-to-date and offers a most accurate basis for the diagnosis and treatment of one of the most difficult problems with which the otologic surgeon is confronted. Here again the new illustrations are very helpful.

Chapter XI is new and discusses "Laboratory Aids to Otological Diagnosis." This chapter discusses at length the various laboratory aids to diagnosis. The proper deductions to make are pointed out at length and emphasis is placed on the necessity for every otologist to be able to interpret properly the findings in every case.

The last one hundred pages are devoted to cases illustrating points in the text.

CLAUDE G. CRANE

A TEXTBOOK ON ORTHOPEDIC SURGERY. By WILLIS C. CAMPBELL, M.D., 8vo., cloth; pp. 705. Philadelphia, W. B. Saunders Company.

One of the most striking evidences of the changing aspect of orthopædic surgery is Campbell's new textbook. Time was when mechanical methods dominated in treatment; it is evident after perusing this book that now the methods of operative surgery are definitely in the ascendancy.

The publisher's announcement of a "refreshing" book is thoroughly substantiated. The subject is treated in a straightforward manner. Controversial matter is largely eliminated, and theoretical discussion is reduced to a minimum. There remains, however, the conviction that the author's experience is broad and his interpretations sound. The book plunges at once into

the matter of what may be gained from the systematic examination of joint function. This portion of the book is particularly valuable, since the need for such instruction is great. There follows upon this a discussion of affections of joints, which includes practically a quarter of the volume. In this portion is included the general pathology and symptomatology of the chronic arthritides besides a similar elucidation of joint tuberculosis as a logical consequence of that discussion. This serves to place the latter in its proper place from two standpoints: (1) as a question of joint pathology and treatment, and (2) as a question of the general therapy of tuberculosis.

The sections of the book devoted to the author's own great contributions to joint surgery are of special interest to the specialist. The indications for operation are pointed out, and the technic of the operations well illustrated by original drawings. There are three chapters on fractures and dislocations, which matter is necessarily handled in a concentrated manner, but it is intensely practical. The author in general favors manipulative reduction of fractures, with fixation in plaster-of-Paris. Traction methods are not illustrated. The nomenclature of fractures of the hip is a little confusing, in that what is ordinarily called a subcapital fracture is illustrated as a central fracture of the neck of the femur. On the other hand, central fracture of the acetabulum is discussed as a central dislocation of the hip.

The rest of the book deals with the ordinary material of orthopædic surgery, and includes a section on bone tumors. The surgery of poliomyelitis is illustrated with a number of the author's own operations.

The book is to be highly recommended as a concise exposition of a difficult subject.

ARTHUR KRIDA

# MEMOIR

DR. JOHN DIKEMAN RUSHMORE

1845-1929

DR. JOHN DIKEMAN RUSHMORE was born in Brooklyn, N. Y., September 5, 1845. The Rushmores came from England in 1621. From the Dikemans also he inherited qualities characteristic of the sturdy old English and Dutch stock. He graduated from Williams College, Mass., in 1867. He then matriculated in the College of Physicians and Surgeons in New York, from which he received his degree of Doctor of Medicine in 1870. He thereupon accepted a service in the Children's Hospital on Randall's Island and later became associated, as attending surgeon, at the Brooklyn Hospital where for a time he was responsible for all the orthopædic work.



JOHN D. RUSHMORE, M.D.

He was a musician of ability, playing both organ and piano equally well. He was a notable Shakespearean scholar. In his personal contact with his patients and his colleagues he was always the gentleman, courteous and kindly.

Doctor Rushmore was associated with the Long Island College Hospital for fifty-four years. He taught in the College for thirty-five years and during that time was Dean of the Faculty and occupied the Chair of Operative and Clinical Surgery. The list of positions held at this institution is long and varied and speaks eloquently for the great versatility of the man. In 1873 he became lecturer in elementary surgery, holding this position until 1875 when he was made lecturer on *Materia Medica* and Therapeutics. He held this post from 1875 until 1877. Thereupon he was promoted to the grade of Professor of the Principles and Practice of Obstetrics and of Clini-



cal Obstetrics. In 1880 he received his major appointment in the College, that of Professor of Surgery, a position he held until 1915. In that year, at the age of seventy, in full possession of his faculties and still keenly interested in all that pertained to the Long Island College Hospital, Doctor Rushmore tendered to the faculty his resignation. He had acted furthermore in the capacity of Dean of the College from 1903 to 1915.

For fifty continuous years he gave his services to the sick poor of St. Peter's Hospital. He served as Chief Surgeon of this hospital for thirty-five years, and during that time performed practically all the major operations. It was at this hospital that Doctor Rushmore is credited with having performed the first appendectomy and the first gall-stone operation in Brooklyn. He was active in the discharge of his duties at St. Peter's Hospital until a short time prior to his death. General Surgery, even as he became master of it, did not represent his entire surgical activity. He conducted an active service in the Brooklyn Eye and Ear Hospital from 1872 until 1914 and had an unusual interest in diseases of the eye and ear and performed numerous operations on both. He once stated that he was the first man to look into his own eye which he was able to do by means of some kind of ophthalmoscope which he had rigged up for himself. Doctor Rushmore was also the first in Brooklyn to attempt the removal of a foreign body from the lung by means of bronchoscopy. In 1914 he became Consulting Ophthalmic Surgeon at the Brooklyn Eye and Ear Hospital which position he held until his death. He acted as consultant in surgery in various of the Brooklyn Hospitals, among which were the Bushwick, St. Anthony's, Kings County, and Swedish Hospitals. The interests of this man were not encompassed even in the activities already mentioned. He found time even to practise a certain amount of obstetrics and pharmacy.

Doctor Rushmore wrote but little. "Ether Anæsthesia" (1892) and "Some Surgical Thoughts on Appendicitis from a Clinical Standpoint" (1894) are among his best known contributions. He held membership in numerous medical societies and clubs, among which were the American Surgical Association, American College of Surgeons, New York Surgical Society, New York Ophthalmological Society and the Practitioners' Club of Brooklyn. In January, 1928, he suffered an attack of influenza after which he never regained his old-time vigor. Finally, March 23, 1929, in his eighty-fourth year, after a few days' acute illness he died.

EMIL GOETSCH

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## COAGULATION OF BLOOD

### 1. THE COMPARATIVE VALUES OF CALCIUM AND GLUCOSE AS AGENTS FOR DECREASING THE CLOTTING TIME\*

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THE hæmorrhage which sometimes occurs after the release of an obstruction of the common bile duct is not as yet definitely understood. Although hæmorrhage is not of as frequent occurrence as it once was, it still is seen often enough to be a complication which is looked upon with considerable dread.

Sufficient work has already been done on the clotting and bleeding time of the blood of patients who have icterus to permit of certain definite deductions. A number of these patients, jaundiced for long or short periods of time, exhibit no evidences of an increase in the time for the clotting of shed blood. Another group have alterations of the clotting time so that shed blood does not coagulate in the normal period of time as estimated by one method or another. However, patients with a prolonged clotting time are not necessarily the ones who bleed after operation. Bancroft, Kugelmass and Stanley-Brown<sup>1</sup> have concluded that the coagulation and bleeding time are of very little value in determining a hæmorrhagic tendency. They have determined from a study of a number of factors, the coagulation index. Their study is an important one and emphasizes the fact that the coagulation time is not a prognostic index to be depended upon. It has also been our experience that a return to a normal coagulation time after treatment is not sufficient evidence that post-operative oozing will not occur.

Pre-operative treatment of the jaundiced patient by a variety of methods has been employed to prevent post-operative hæmorrhage. Such treatment will in many instances cause a reduction in the coagulation time with a return to values well within normal limits. It frequently happens that when two or more substances are used in the preparation or treatment of patients suffering from a disease, we empirically attribute beneficial results to the drug which most likely might have been supposed to bring about those results. This may not in any way be supported by either prolonged clinical observation or by experimental fact. It may happen that several interrelated factors act favorably to bring about the desired result or that one factor in itself might have brought it about if used alone. Such information can only be obtained by careful clinical and laboratory analysis.

\* Read before the conjoint meeting of the Philadelphia Academy of Surgery and the New York Surgical Society, February 13, 1930.

Since Whipple<sup>2</sup> and Walters,<sup>3</sup> independently, suggested the use of calcium solutions in the pre-operative preparation of jaundiced patients, it has been customary to use a solution of calcium salts intravenously, before operation, in the majority of clinics in this country. Previous to their work, Mayo-Robson had suggested that calcium salts would be helpful in restoring a disturbed calcium balance in the jaundiced patient. Because calcium is known to play some part in coagulation, its use has become widespread even though, with one exception, no one has demonstrated a calcium deficiency in obstructive jaundice in the clinical patient.

Simultaneous with the widespread use of calcium solutions in these cases, surgeons began using solutions of glucose, to increase the hepatic glycogen reserve and thus improve the hepatic function. It has been known that certain liver degenerations give rise to a condition where clotting of shed blood is delayed. Since glucose causes rapid liver repair, it might be supposed that improvement of liver function, after its use, would reflect itself in a number of ways.

For many reasons it seemed worthwhile to ascertain whether or not calcium was necessary to reduce the clotting time in patients suffering from obstructive jaundice. If calcium was not necessary, to what factor might we attribute the reduction of the coagulation time, which has been observed clinically after preparation of the jaundiced patient, when an abnormal increase existed, and what factor or factors were responsible for a reduction in the number of post-operative hæmorrhages in jaundiced patients?

We have therefore studied the effect of calcium and glucose on the coagulation time of the normal and jaundiced dog and of the jaundiced patient. Besides these we have observed the effect of a few other salts and sugars. We are reporting here only the results of the use of calcium and glucose.

The coagulation time was determined in all experiments by the Lee-White<sup>4</sup> method. After experience with a variety of methods we believe that this procedure gives more uniform results than any other we have tried. The blood samples from the dogs have been taken in most instances by arterial puncture so as to avoid trauma and the application of a tourniquet during withdrawal of the blood. We know that even this method is by no means quantitative and have taken the rather arbitrary point of 25 per cent. reduction in the clotting time as definite evidence that one or another of the substances used had a beneficial action.

*The Effect of Calcium on Liver Degeneration.*—Minot and Cutler<sup>5</sup> have recently reported that calcium salts exerted a highly protective action in preventing and treating the increase in guanidine and guanidine-like substances in the blood of dogs suffering from liver degeneration following the administration of chloroform and carbon tetrachloride. Although no definite relationship between the increase in guanidine and hepatic damage has been established, they believe that the liver damage probably accounts for the abnormal blood guanidine.

Partos and Svec<sup>6</sup> report that the intravenous injection of calcium chloride

causes a hyperglycæmia, but we cannot agree that this is a consistent finding. On the other hand, one of us (C. R.) has recently obtained data which would lead us to believe that the prolonged administration of calcium exerts a beneficial action in the liver damage of ductal obstruction. However, the administration of calcium was continued for a much longer period than has been heretofore reported in clinical practice.

*Calcium and Blood Coagulation.*—The literature on this subject has been covered by Wangensteen<sup>7</sup> in an excellent article published in this journal. Much of the work that has been done is of little value since the methods used for estimating the coagulation time were open to too many errors.

In a study on calcification made several years ago by one of us (I. S. R.) with M. E. Morrison, we were able to study a series of dogs who had serum calcium values of from 4 to 8 milligrams per 100 cubic centimetres. These animals exhibited no evidences of an increase in the coagulation time. We were fortunate in being able to study the coagulation time of a patient who had parathyroid tetany following the accidental removal of parathyroid glands during thyroidectomy. This patient, with a serum calcium of 4.6 milligrams per 100 cubic centimetres, had a normal coagulation time. Similar results have been reported by Simpson and Rasmussen,<sup>8</sup> while Kottman and Lidsky<sup>9</sup> reported a decrease in the coagulation time in parathyroidectomized dogs.

A study of the coagulation time of the blood in two dogs whose serum calcium values had been elevated after the administration of activated ergosterol and parathormone respectively was made. The dogs' serum calcium values were 20 and 26 milligrams per 100 cubic centimetres respectively. In both of these, the coagulation time was high normal or above normal for the method used; 9.18 and 12.5 minutes respectively. Our data do not agree with the results obtained by Gordon and Cantarow,<sup>10</sup> and Cantarow, Dodek and Gordon,<sup>11</sup> who found that parathormone (Collip's Extract) given to normal and jaundiced patients caused a consistent reduction in the coagulation time.

The study of the serum calcium of over twenty-five jaundiced patients and a large series of adult dogs with experimental jaundice has never disclosed any appreciable reduction from normal values. One patient had a serum calcium of 8.8 milligrams per 100 cubic centimetres while the dogs have all been within normal limits. Snell, Greene and Rowntree<sup>12</sup> and numerous other observers have obtained similar results. Buchbinder and Kern<sup>13</sup> have been the only investigators who have reported a progressive decrease in serum calcium in experimental jaundice. They used young puppies. They also reported three patients with jaundice who had low serum calcium values which returned to normal with a decrease of the jaundice. The results of these workers stand alone in a wealth of evidence.

A number of papers have appeared which have attempted to differentiate the rôles of ionizable and non-ionizable calcium in the clotting process. Vines,<sup>14</sup> who studied this aspect of the subject, came to the conclusion that

ionized calcium is not necessary in the clotting process. The addition of oxalate, citrate or fluoride to normal blood in amounts chemically equivalent to the total calcium of the blood does not inhibit coagulation. Vines believed that the above anti-coagulants all inhibited clotting primarily, by combining with a calcium-containing complex; the amount of anticoagulant required to neutralize the action of the complex was in each case in excess of the chemical equivalent of the calcium attached to it.

Stewart and Percival<sup>15</sup> studied the delay in coagulation of ox blood after mixing it with varying amounts of anticoagulants, citrate, oxalate, fluoride, etc. They decided that ionizable calcium had nothing to do with coagulation; if anything, it lengthened the coagulation time. They, however, did believe that a complex protein-calcium compound, the identity of which they did not determine, played a definite part in the clotting process.

We have studied the effect of calcium chloride and calcium gluconate (Sandoz) on the coagulation time of the blood in normal and jaundiced dogs. The calcium was given to some dogs on successive days as it is given in the preparation of the jaundiced patient; in others, the coagulation time was determined after a single injection.

TABLE I

*Effect of Repeated Administration of Calcium Gluconate After Cholecystectomy and Ligation of Common Duct*

Number of dog	Normal coagulation time in minutes	Operation	Coagulation time in minutes	Van den Bergh (units)	Calcium gluconate 10 c.c. 10 per cent	Coagulation time on following day
432.....	4.8	22	4.1	16.5	Days after operation 22-23-24	4.8
405.....	7.7	8	5.5	12.0	24-25-26 27-28	6.0

In Table I are given the results obtained after repeated subcutaneous injections of calcium gluconate to two dogs who had the gall-bladder removed and the common duct ligated.

In Table II we include the results obtained in six normal dogs after a single intravenous injection of calcium chloride or calcium gluconate.

These experiments fail to demonstrate the value of calcium in causing a consistent reduction of the coagulation time in the normal dog. In only one instance was a 25 per cent. reduction in the coagulation time noted. This was in dog No. 519 where the maximum reduction was 42 per cent. after a single injection of calcium.

*The Use of Glucose in Liver Degeneration.*—Schreiber,<sup>16</sup> in 1913, and Kehr,<sup>17</sup> a year later, suggested the use of glucose previous to operation on jaundiced patients. Its use became widespread in this country after 1920. Walters advocated the administration of glucose in conjunction with calcium chloride. There can be little doubt that the administration of glucose has

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been a major factor in the reduction of the surgical mortality attending operative procedures for obstructions of the common duct.

Davis, Hall, and Whipple<sup>18</sup> have shown that a high carbohydrate diet will cause liver regeneration at the rate of 100 grams a day, in the degeneration following chloroform. We have shown that following the release of ductal obstructions a carbohydrate diet will result in a more rapid return to normal histologic structure than any other diet. Even when ductal obstruction exists, we believe that the administration of glucose exerts a beneficial effect although the liver cannot deposit glycogen in normal amounts.

Liver degeneration occurring as the result of chloroform or phosphorus

TABLE II  
*Effect of Single Injections of Calcium Salts*

Number of dog	Normal coagulation time in minutes	Days after operation	Injection	Coagulation time 15 minutes after injection	Coagulation time 1 hour after injection
519.....	6.3	11	10 c.c. cal. gluc.	5.4	3.6
199.....	7.0	None	10 c.c. cal. gluc.	7.9	6.8
461.....	5.7	None	10 c.c. cal. gluc.	6.2	5.2
512.....	5.8	None	10 c.c. cal. gluc.	4.5	4.9
515.....	4.4	None	10 c.c. cal. gluc.	5.0	4.6
786.....	7.3	None	10 c.c. Ca Cl <sub>2</sub>	5.8	7.7

poisoning frequently is associated with an increase in the coagulation time. An increase in the clotting time may or may not be associated with the degeneration which occurs after obstruction of the common duct. In our experience, the clinical cases which have prolonged clotting times have also severe liver damage. The exact cause of the increase in the coagulation time after liver degeneration is not definitely understood. McMaster and Drury<sup>19</sup> have shown that, at least in the rabbit, the liver is the sole source of blood fibrinogen. Mann, Bollman and Markowitz<sup>20</sup> have, on the other hand, found that the coagulation time of the blood following complete removal of the liver is variable. In some animals it remained normal for twenty-four hours after hepatectomy. In others, it was delayed immediately after operation but was normal at later periods; while in still others there was a progressive increase in the coagulation time up to failure of coagulation. They believe that the delay in coagulation time of the blood in their animals was due to deficiencies in the blood fibrinogen although they state that a simple relation-

ship does not appear between fibrinogen content and coagulation time. This latter observation we have confirmed in normal and jaundiced dogs.

It is interesting to note here that in Minot and Cutler's experiments, which we reviewed under the discussion on calcium therapy, the increase in blood guanidine observed in their dogs was soon followed by a marked fall in the blood sugar which at times reached levels of marked hypoglycæmia. Ellis<sup>21</sup> has found that glucose acts protectively in presenting the toxæmia resulting from the injection of guanidine. Furthermore, both observers found that the injection of guanidine resulted in hypoglycæmia. Such observations add further evidence to the protective action of glucose in hepatic disease.

We might reasonably say that as far as information is now available, intravenous glucose gives better results in the various types of liver degeneration than any other substance so far used. It seems reasonable to suppose that the less liver damage existing, the less will be the danger of hæmorrhage.

*The Effect of Glucose on the Coagulation Time of the Blood.*—Experimental evidence has been advanced which indicates that with an increase in the blood sugar there is a decrease in the coagulation time. Partos and Svec in 1927 reported an exact parallelism between the coagulation time and the blood sugar content. In effect they found that substances which reduced the coagulation time caused hyperglycæmia by mobilizing glycogen while those substances which increased the coagulation time decreased the blood sugar. Cannon and Gray<sup>22</sup> have found that an increased output of adrenalin, which causes a hyperglycæmia, resulted in a decrease in the coagulation time. Rabinowitch<sup>23</sup> observed a decrease in the coagulation time following inhalation anæsthesia. The maximum reduction occurred within the first fifteen minutes after induction of the anæsthesia. Anæsthesia also causes hyperglycæmia.

Boldyreff,<sup>24</sup> in an article entitled "The Pancreatic Triad," came to opposite conclusions. He states that the hyperglycæmia which he found associated with "a complete loss of pancreatic fluid either by pancreatectomy or fistula produces (1) a rise in the percentage of blood sugar, and (2) a decrease of the blood coagulability." Turcatti,<sup>25</sup> using a similar procedure, obtained results similar, but not so consistent as those of Boldyreff. He does not report the method which he used for determining coagulation time. The figures given by him are very short and a doubt exists in our minds as to the accuracy of the method used.

It has been our experience that although a reduction of the coagulation time is frequently associated with an increase in the blood sugar, the two do not consistently parallel each other. We have studied the effect of glucose given intravenously and by mouth on the normal and jaundiced dog and on the jaundiced patient. We have furthermore estimated the effect of glucose on the jaundiced dog after the animal had received calcium gluconate (Sandoz) for several days previous to the administration of glucose.

Table III shows the effect of glucose on a group of normal animals.

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Twenty-one estimations were made. In 86 per cent. of the injections a reduction of the coagulation time of 25 per cent. or more was obtained. In 38 per cent. the reduction was from 25 to 50 per cent.; in 48 per cent. it was

TABLE III  
*Effect of Glucose Administration to Normal Dogs*

Number of dog	Normal coagulation time in minutes	Gms. of glucose intra-venously	Coagulation time 15 minutes later	Coagulation time 1 hour later	Coagulation time 2 hours later	Coagulation time 3 hours later	Coagulation time 4 hours later	Coagulation time 6 hours later
841.....	6.1	37.0	3.3				4.6	
65.....	5.5	22.0	4.0	4.1	3.1			
844.....	5.9	34.0	4.6	4.5				
831.....	9.4	23.0	3.9		3.6			
85.....	5.9	24.0	4.3		3.9			
761.....	5.1	17.0	3.4		2.7			
30.....	3.9	30.0	2.7		2.9		3.2	
30 A.....	6.4	16.5	4.9					
30 B.....	7.9	30.0	4.1	3.7				
712.....	6.4	16.5	4.9		3.0			
17.....	6.1	22.5	4.6		4.7		3.4	
30 C.....	3.8	10.0	1.8					
513.....	9.1	27.0	5.6					
733.....	4.1	18.0	3.2					
690.....	5.1	18.5	2.9	3.8				
642.....	7.8	25.0	6.5					
773.....	5.8	21.0	2.0					
833.....	9.7	32.0	5.8		6.1			
199.....	6.3	10.0	5.2	2.7				
199 B.....	7.5	10.0	2.1					
71.....	10.2	21.0	4.9				6.2	

more than 50 per cent. There were 14 per cent. of failures. This is in marked contrast to the results obtained from normal dogs after the administration of calcium salts where only 16.6 per cent. of positive results were obtained.

TABLE IV  
*Effect of Glucose Given to Jaundiced Animals*

Number of dog	Normal coagulation time in minutes	Gms. of glucose intra-venously	Coagulation time 15 minutes later	Coagulation time 1 hour later	Coagulation time 2 hours later	Coagulation time 3 hours later	Coagulation time 4 hours later	Coagulation time 6 hours later
27.....	12.1	20.0	4.5		5.5			
432.....	4.1	50.0 *	4.2	2.2	3.5			
411.....	7.5	23.5	4.5		5.2			
405 A.....	5.4	50.0 *	5.7	4.31	3.5			
405 B.....	8.4	50.0 *	8.4	5.26	2.1			

\* Glucose given by stomach tube.

Table IV gives the results obtained following the administration of glucose to animals with experimental obstruction of the biliary passages. In two instances, the glucose was given intravenously while in three it was given by stomach tube. In the later instances, it will be seen that the maxi-



TABLE V  
*Calcium and Glucose*

Number of dog	Normal sugar in mg.	Normal coagula- tion in minutes	Ca. gluc. subcutaneously	Coagula- tion time 24 hours after last Ca. in- jection	Gms. glucose by stomach tube	Blood sugar 15 minutes later in mg.	Coagu- lation time 15 minutes later.	Blood sugar 45 minutes later	Coagu- lation time 45 minutes later	Blood sugar 1 hour, 15 minutes later	Coagu- lation time 1 hour, 15 min- utes later	Blood sugar 2 hours later	Coagu- lation time 2 hours later
432.....	75	4.8	3 daily injec- tions, 20 c.c. of 10%	4.8	50.0	141	4.7	176	4.5	198	1.6	207	1.7
405.....	81	7.7	5 daily injec- tions	6.0	50.0	158	4.2	198	5.8	192	2.4	194	3.8

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imum reduction of the coagulation time occurs later than in the former. Every animal gave positive results. In 40 per cent. a reduction of 25 to 50 per cent. was obtained while in 60 per cent. a reduction of 50 per cent. or more was obtained.

Two jaundiced dogs were studied before and after repeated injections of calcium gluconate (Sandoz) similar to the method used for preparing jaundiced patients for operation. Table V gives the coagulation time before the administration of calcium; twenty-four hours after the last injection; and the coagulation time in the same animals subsequent to the administration of glucose by stomach tube. The calcium had practically no effect on the coagulation time while glucose caused a reduction of 60 and 69 per cent. respectively.

In two dogs we studied the effect of the intravenous injection of glucose after hepatectomy. Table VI gives the normal coagulation time; the coagulation time fifteen minutes after the completion of the final stage of the hepatectomy; and again two hours later. These animals had a rise in the coagulation time of 38 and 48 per cent. respectively.

TABLE VI  
*Hepatectomy and Glucose*

Number of dog	Normal coagulation time in minutes	Hepatectomy	Coagulation time 15 minutes later	Glucose continuously	Coagulation time 2 hours after hepatectomy
III.....	10.5	Hepatectomy	9.1	43 gm.	14.0
713.....	8.6	Hepatectomy	7.9	53 gm.	12.8

It seemed possible that glucose might act by stimulating the formation of fibrinogen. A careful study of the blood fibrinogen in normal and jaundiced animals before and after the administration of glucose has thrown no light on the mechanism by which glucose acts. We have not found any definite increase in the blood fibrinogen associated with the decrease in the coagulation time after glucose administration.

The results obtained following the intravenous administration of glucose to six jaundiced patients is interesting. They are given in Table VII. The first case was one of advanced liver damage who died eight hours after admission. Glucose was without effect. We are indebted to Dr. G. P. Muller for permission to study her, as well as the second and third cases. The last patient had a carcinoma of the bile ducts. Here also glucose was without effect, while calcium did cause a very slight reduction of the coagulation time. Dr. E. L. Eliason, who kindly gave us permission to study this patient, reported a very seriously damaged liver. Whether the calcium alone was the factor causing a reduction in the coagulation time or not we cannot definitely state, but it would appear that this was the case.

*Summary and Conclusions.*—It would seem that except in very rare instances ionized calcium does not favorably affect the coagulation time of the blood of normal or jaundiced dogs. Glucose, on the other hand, given by

mouth or intravenously does favorably affect the coagulation time in both types of animals in the majority of instances. Glucose causes a reduction in the coagulation time in patients with obstructive jaundice when the liver damage is not beyond the stage of partial repair. Glucose has no effect on

TABLE VII  
*Effect of Glucose Administered to Jaundiced Patients*

Name	Van den Bergh (units)	Coagulation time before glucose	Glucose intravenously	Coagulation time immediately after	Coagulation time 1 hour later	Coagulation time 2 hours later	Coagulation time 3 hours later
Mrs. M. ....	33.0	25.0	100 gm.	20.3		28.0	
Mrs. S. M. ....	11.0	13.3	100 gm.	3.8			
Mrs. I. T. ....	16.0	6.8	90 gm.	4.5			
Mrs. H. ....	11.0	10.9	100 gm.	3.0		3.6	
Miss E. N. ....	18.5	7.5	100 gm.	4.5		3.2	
Mr. E. C. ....	20.0	70.6	110 gm.	55.2	79.5 *	51.0 †	25.2 ‡

\* Calcium chloride 10 c.c. 10 per cent. intravenously.

† Twenty minutes after calcium.

‡ Thirty minutes after calcium.

the coagulation time after hepatectomy. Given to both the normal and jaundiced dog, glucose causes no increase in the blood fibrinogen.

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# BONE METASTASES IN CANCER OF THE BREAST\*

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IN THE six-year period from 1924 to 1929 inclusive 267 patients with breast cancer were registered in the Radiological Department of the Philadelphia General Hospital. The great majority of these patients were in the late stages of the disease—being inoperable or having recurrence after operation—and only a few came sufficiently early for radical operation. Many of the 267 succumbed from extensive visceral metastases before sufficient time elapsed to develop bone metastasis. In this group were two patients with typical inflammatory type of cancer of the lactating breast and they died in three and nine months respectively. Of this number 204 had more or less extensive X-ray examination of the skeleton by Dr. E. Burvill Holmes. Of the 204 röntgenographed, 101 (49.5 per cent.) gave definite evidence of bone metastases.

Of these 101 patients 100 were women and one a man. We now have under our care another man with cancer of the breast showing metastases to the bones of the shoulder girdle homolateral to the affected breast. The average duration of life as given in their histories from onset of symptoms to death in the eighty-six who have died is twenty-eight months. This average duration no doubt would have been much longer except for many of these patients being psychopathics or of such low intelligence that their own or their relatives' first recognition of the primary tumor was in the stage of beginning ulceration. In the fifteen with bone metastases alive on January 1, 1930, the average duration since the first onset of breast symptoms was ninety and six-tenths months.

There was no reasonable doubt as to the correctness of the clinical diagnosis of primary breast cancer in any of these late cases of bone metastases but microscopic confirmation was made at the original operation, usually at other hospitals, in thirty-four; by biopsy in six; and at autopsy in thirty-nine.

Of the 103 patients who did not show bone metastasis at the time they were röntgenographed twenty-seven were alive on January 1, 1930. It is probable some of them will develop bone lesions before death.

Bone metastases in our series of 101 cases were found in the skull in fourteen; cervical vertebræ in ten; thoracic vertebræ in forty-one; lumbar vertebræ in forty-four; pelvic bones in forty-five; femora in thirty-two; leg bones in seven; foot bones in four; shoulder girdle in fifty-four; forearm bones in six; bones of hand in four; and ribs in thirty-five. Involvement of

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cervical vertebræ was probably much more frequent than the figures indicate because skiagrams of cervical regions in many cases were inadequate to determine whether or not metastases were present. In several cases in which lateral views of the thoracic and lumbar spine were not taken there may also have been more vertebral involvement than we have indicated.

In all of the 101 cases the bone lesions were destructive in type but in two of them with negative Wassermann reactions there was associated osteosclerosis. The first effect of metastasis was to cause osteoporosis and then followed, possibly as a result of nature's efforts at repair, an osteosclero-



FIG. 1.—Combined osteoporosis and osteosclerosis

sis in the same region. The most distant areas of invasion all showed porosis and inside these distant areas sclerosis was the rule. (Fig. 1.) That the bone lesions in one of these two cases were cancerous was confirmed by microscopy of bone sections obtained at autopsy. These findings are similar to those usually encountered in bone metastases secondary to prostatic cancer as illustrated by the set of röntgenograms exhibited at the meeting but not reproduced in this printed article and also by röntgenograms of a case reported in an earlier paper.<sup>1</sup> The most common cause of bone metastases is mammary cancer in women and prostatic cancer in men.

The following two cases displayed the most extensive bone metastases—and Case I the most extensive skin nodules also—that we found in this series.

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CASE I.—A white woman, seventy years of age, the mother of three children, was admitted to the Radiological Department of the Philadelphia General Hospital December 3, 1928. She gave a history of having had excised from her right breast in August, 1926, a nonulcerated lump which had been present for two years. The hospital at which the operation was performed reported the pre-operative diagnosis was "fibroma" and the post-operative microscopical diagnosis was "carcinoma simplex, scirrhus type." The patient received no further treatment of any kind and the family was not aware that the patient had cancer until three days before coming to us.

About four months after operation she first noticed small lumps in the skin overlying the chest. These nodules increased in number, being most marked over the torso front and back, but extending to the top of the head and downward to wrists and knees. She soon developed sharp stabbing pain in the back and shoulders which interfered with sleep but she was able to go about actively until one year ago when she



FIG. 2.—Cutaneous nodules of face, arms and anterior chest and abdomen, due to lymphatic permeation.



FIG. 3.—Lymphatic permeation nodules of back and arm.

began having pain in region of right hip and swelling of right leg. She is now barely able to hobble around with the aid of a cane. She has had constant dribbling of urine for the past year.

Patient is emaciated. On inspection the most striking feature is a widespread distribution of cutaneous nodules. (Figs. 2 and 3.) They can be felt throughout the scalp; are particularly numerous around the angles of the jaws where they prevent opening of the mouth more than one centimetre. Nodules mechanically cause ptosis of upper lids which is complete on right and partial on left. Extensive coalescence of nodules over chest, abdomen and back presents an appearance somewhat resembling cancer en cuirasse. Over arms, forearms and thighs nodules are more distant one from another, extending down to the crease of each wrist, and in one hand two subcutaneous nodules are not seen but are easily palpable in the thenar eminence. Visible nodules extend bilaterally to the line of the knee-joint and palpable deeper nodules extend two inches below the knee on each side. Subcutaneous nodules are palpable throughout the area involved by skin nodules. The inguinal and saphenous lymph nodes are enlarged and indurated. Nodules quite similar to those on the skin are present in the mucosa of the mouth and vagina. Labia and adjacent skin are thickened and infiltrated. Digital

examination reveals induration of the lateral and anterior walls of the rectum. The right breast, which was the site of the original lesion, seems curiously free from evidence of cancer although its overlying skin is studded with nodules. Isolated nodules have reached the size of a silver half dollar. Their edges are raised above the surrounding skin but their centres are depressed by fibrous umbilication.

Mild pinching of skin or firm pressure anywhere causes severe distress. Examination of lungs not very satisfactory because of greatly lessened respiratory excursion due probably to extensive involvement and rigidity of overlying skin and subcutaneous tissues. Liver not demonstrably enlarged.

Röntgenograms of the entire skeleton reveal metastases in all the bones (Figs. 4 to 15) down to the ankles. The astragalus, os calcis, scaphoid and cuboid show early



FIG. 4.—Metastases in bones of cranium, face and upper cervical spine.

invasion in each foot. It is rare to find as extensive invasion of the hands as is shown in many of the terminal phalanges.

On the third day after admission the patient's family was informed she could not be cured and they took the patient home where she died five days later. No autopsy.

CASE II.—A fifty-six-year-old white mother of four children was admitted to the Radiological Service October 2, 1928. Her left breast was amputated for cancer March 21, 1916. In August, 1927, she began having pain in both hips extending down right leg to middle of tibia which caused her to limp for the past year. About August 1, 1928, while walking in her home, the right leg near its middle "bent under her." About four months before admission her physician stated she had a fracture of the right clavicle.

The patient was somewhat emaciated and her chief complaint was pain, mainly at back of neck and in right leg. On examination nothing very noteworthy found except

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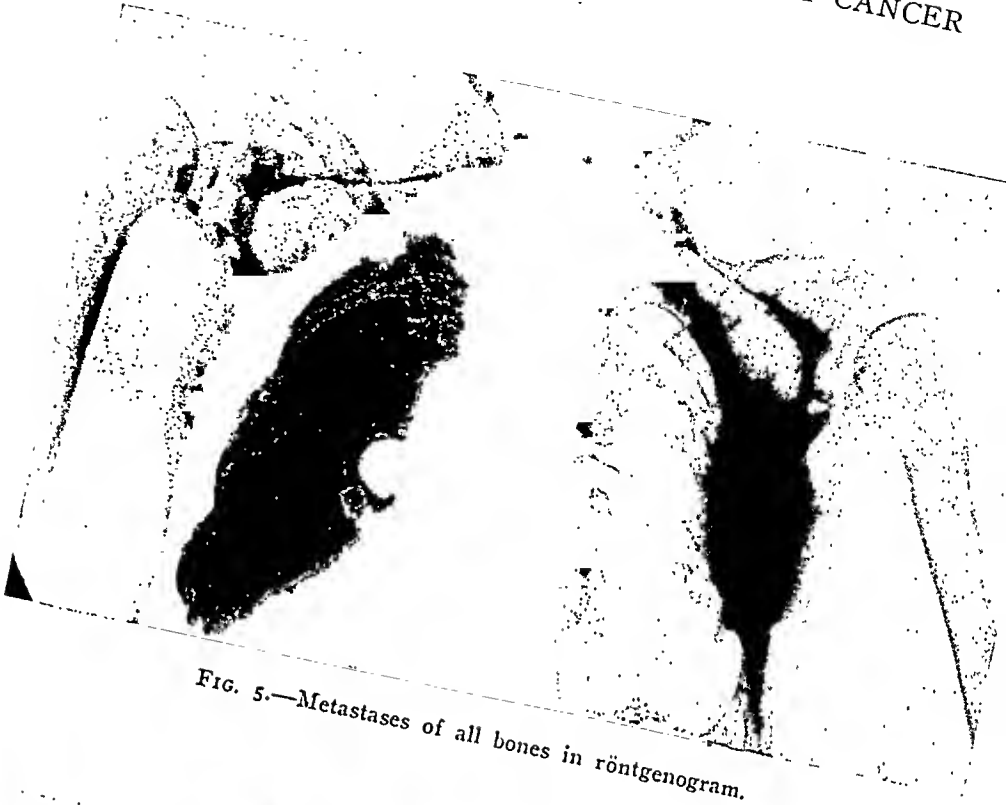


FIG. 5.—Metastases of all bones in röntgenogram.



FIG. 6.—Left humerus, radius and ulna.



FIG. 7.—Right humerus, radius and ulna.



FIG. 8.—Left hand.



FIG. 9.—Right hand, homolateral to affected breast and bones more extensively invaded than in left hand.



bilateral enlarged indurated supraclavicular and anterior and posterior cervical lymph nodes and the deformities of fractures of right clavicle and of both bones of right leg. No skin nor subcutaneous nodules. Examination of urine was negative. Blood count on Oct. 19, 1928, revealed 3,940,000 red cells, 7,400 white cells and 90 per cent. hæmoglobin—a very mild grade of anæmia in view of the extensive invasion of bone marrow. Differential count gave polymorphonuclears 72, lymphocytes 18, and mononuclears and transitionals 10. Wassermann was negative. Blood sugar was 100 and blood urea nitrogen 11.

Skiagrams are negative for pulmonary metastases but disclose involvement of



FIG 10—Lower chest and lumbar spine.

every bone other than those of the hands and feet (Figs 16 to 28) In the right foot all the bones—even the terminal phalanges—are extensively invaded In the left foot the os calcis and astragalus show very early invasion In the hands some of the carpals, metacarpals and phalanges are very suspicious of early metastases. Fractures are shown in right tibia and fibula, right clavicle and several ribs. The roentgenogram of the spine (Fig 17) was made on the autopsy table after removal of the sternum, adjacent ends of ribs, heart and lungs by a voltage of 30 k. w., an amperage of 5 milliamperes and flash exposure It is interesting to note that in making roentgenograms far less exposure is required in the dead than in the living body. A spine picture in

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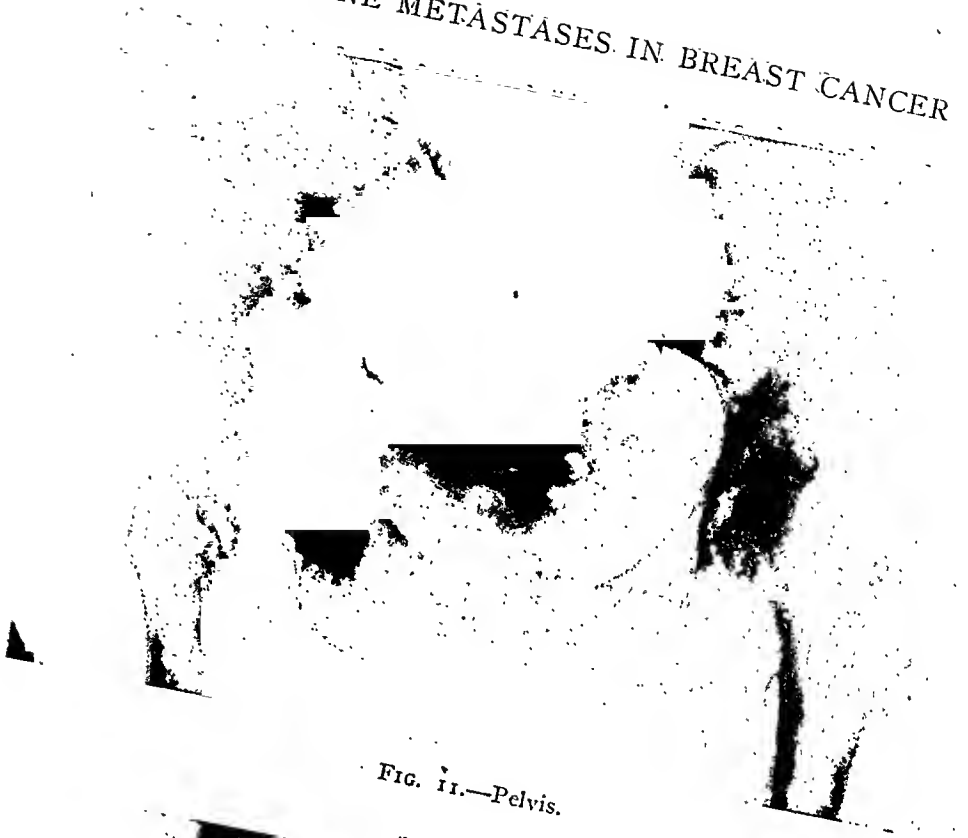


FIG. 11.—Pelvis.



FIG. 12.—Left femur, tibia and fibula.

FIG. 13.—Right femur, tibia and fibula.

the living calls for a voltage of 70-127 k. w., an amperage of 20 milliamperes and an exposure of 12 seconds.

October 13, 1928, patient developed flaccid paralysis of both upper extremities and died October 21, 1928. Autopsy failed to reveal any gross evidence of cancer in the thoracic and abdominal cavities except in the lymph nodes along the abdominal aorta and iliac arteries. The photomicrograph in Fig. 29 illustrates permeation of lymphatics from vicinity of her abdominal aorta. A bone section from the lowermost end of left tibia (Fig. 28) revealed cancer by microscopical examination.

Correct interpretation of röntgenographic evidence is most important in the detection of early bone metastasis. Inexperienced radiologists frequently mistake early metastasis for atrophy of disuse or, especially in the



FIG. 14.—Early metastases in left tibia, fibula, FIG. 15.—Early invasion in right tibia, astragalus, astragalus, os calcis and cuboid.

spine, for beginning osteoarthritis. The bone atrophy of disuse is fairly uniform whereas metastasis is uneven or spotty in distribution. Repetition of rontgenograms in two or three months and comparison with the original ones usually clear up any doubt. The interval between the first symptoms of breast cancer and the onset of bone invasion is extremely variable. Bone metastasis is always a late manifestation and about one-half the cases of uncured breast cancer die without developing X-ray evidence of bone changes.

In our cases of early bone invasion, aside from direct extension to ribs underlying the breast lesion, the order of frequency was the homolateral shoulder girdle, the third to sixth thoracic vertebræ, the upper lumbar vertebræ, the pelvic bones, and the lower cervical vertebræ.

The original röntgenograms supplemented by follow-up pictures at fre-

quent intervals in these early cases revealed many points of interest. Ordinarily it requires an interval of about two months between röntgenograms to note an appreciable progress in the metastatic lesions in bone. In one very exceptional case of rapid extension the first extensive X-ray study revealed metastases only in the homolateral shoulder girdle and one rib underlying the cancerous breast whereas only three months later metastases were found in the thoracic and lumbar spine, the pelvis and femora.

A frequent site of earliest bone invasion we find to be in the shoulder girdle homolateral to the breast cancer. In the earliest cases of shoulder girdle invasion we have seen, the head of the humerus and the glenoid process and adjacent region of the scapula were involved; at a slightly later



FIG. 16.—Skull.

stage invasion of the acromial process occurs and somewhat later the outer end of the clavicle is affected. From this stage the cancer extends gradually to successively adjacent areas in these bones. Quite commonly a second area of invasion occurs at the inner end of the clavicle and spreads outward to meet the invasion extending from the outer end. We disagree with the commonly expressed statements in the literature that metastases to the clavicle and scapula in breast cancer are relatively rare findings.

Studies of the humerus habitually reveal a gradual progressive extension downward and the great majority of patients die before the cancer as shown by X-ray reaches the elbow. In only six of our present series of 101 cases did the cancer extend below the elbow. In four of the earlier of these six and in several other similar cases we have seen (*a*) the radius—usually at a short distance below its head and best shown in supination as X-ray pictures taken in pronation superimpose the shadow of the ulna over the site of

radial invasion—was always invaded before the ulna; and (b) invasion of the radius only occurs after the disease has extended in the humerus to within two inches of the elbow and usually the X-rays fail to reveal evidence of metastasis in this lowermost two inches of the humerus before the invasion of the radius is demonstrable. We have never seen metastasis below the elbow in the absence of metastases throughout the greater part of the length of the humerus.



FIG 17 —Post mortem roentgenogram

Usually several weeks intervene after invasion of the radius before disease is demonstrable in the ulna, commonly at a variable distance from its upper end. The metastases then spread upward and downward finally involving practically the entire shafts of the radius and ulna before metastases are shown in the bones of the wrist and hand. We have never seen metastases in the wrist or hand in the absence of extensive involvement of all three bones of the arm and forearm. As a general rule it may be stated that in metastases in the upper extremity the most advanced destruction is

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found at or near the upper end of the humerus with a gradual lessening in severity downward to the most distant site of invasion.

The vertebræ are frequently the first site of metastases. Apparently almost any vertebra from the mid-cervical to the last lumbar may be the first one affected but there are three sites of special predilection. The first invasion of vertebræ occurs most frequently in the third to the sixth thoracic, less often in the upper lumbar and somewhat less commonly in the lower cervical. Not infrequently vertebral metastases may appear in two of these sites simultaneously.

The first X-ray evidence of metastasis anywhere is found exceptionally in the bones of the pelvis and very rarely in the femur.



FIG. 18.—Left shoulder girdle and humerus.

FIG. 19.—Right shoulder girdle and humerus.

Invasion of the femur usually begins in the head and is then nearly always associated with similar invasion of the acetabulum and adjacent bone. As in the upper extremity, we find an orderly downward extension which gradually descends the femur to within a couple inches of its lower end, when the metastasis will make its first appearance below the knee, and affects the upper tibia before involving the fibula; it then progresses down these bones to near the ankle before invading the tarsus.

In both upper and lower extremities the bone invasion is usually bilateral and fairly equal in intensity and in progression on the two sides. Furthermore invasion in the femur, though a bit later in onset, keeps fairly uniform pace with the invasion of the humerus. The progress of the disease in the tibia and fibula is about on a par with that in the radius and ulna. In only two of our 101 cases—to be referred to later—has there been any noteworthy



FIG. 20.—Left humerus, radius and ulna.



FIG. 21.—Right humerus, radius and ulna.

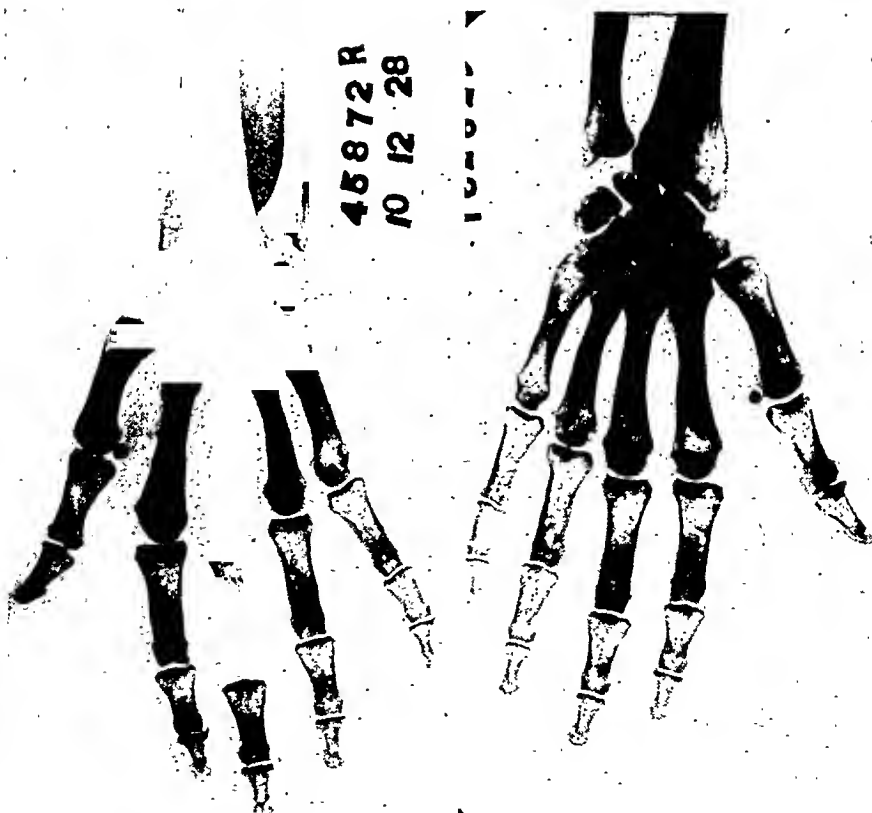


FIG. 22.—Right and left hands showing early invasion of some of carpals, metacarpals and phalanges.

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departure from this gradual peripheral spread of metastases in the lower extremities.

It is inconceivable that blood-stream emboli or lymphatic emboli could give rise to the orderly extension of cancer in the bones such as we have described. Supporters of the theory of vascular emboli of cancer cells always causing bone metastases claim that the theory of lymphatic permeation has not been adequately proven. We feel justified in retorting that the



FIG. 23.—Lumbar spine.

vascular embolic theory has likewise not been proven. Lymphatic permeation of cancer cells is the only known process in the spread of cancer that could rationally account for our bone findings.

In the earliest stage of invasion anywhere, the bone affected usually presents a mottled appearance indicative of multiple foci of cancer developing simultaneously from lymphatic permeation rather than a single focus such as would be expected in blood embolism.

Sarcoma metastasis is unquestionably due to blood-stream emboli but beyond the primary invasion of the lungs from sarcoma in the systemic



circulation or of the liver from the portal circulation no one can predict the site of further manifestations of metastases. Aside from the lungs and liver it is characteristic of sarcoma vascular emboli to distribute metastatic deposits after a most haphazard and lawless fashion. Certain types of cancer—especially primary cancer of the liver and kidney—are particularly prone to metastasize to the lungs by way of the blood-stream. Cancer cells from the breast may also invade the blood-stream, especially in the terminal



FIG 24 —Pelvis and upper femora

stage of the disease, but it is unusual to find evidence of vascular emboli at a distance from the breast other than in the lungs or brain.

In two of our series of 101 cases we believe the bone lesions were caused in part by vascular emboli. In our Case II the lesions in the right tibia, fibula and bones of the foot and ankle (Fig. 27) indicate vascular emboli as their origin because they are so much farther advanced than the lesions in the corresponding bones on opposite side and in both femora, which latter lesions are the ones customarily found. This case is the only one either in this series or in our entire practice in which we have seen advanced bone lesions anywhere below the knee. We believe that in Case II a vascular embolus lodged in the shaft of the tibia or fibula and started up a local nidus

of metastasis and from that nidus the cancer was extended by lymphatic permeation. The second case of probable vascular embolism occurred in a patient who was admitted with a pathological intertrochanteric fracture of the femur and extensive radiograms failed to show any other bone lesions. Further X-ray studies were not made until eleven months later when there were

found the early metastases of lymphatic permeation in the homolateral shoulder girdle, ribs, thoracic and lumbar vertebræ and both femora. The intertrochanteric fracture had united. The great majority of pathological fractures unite with no special difficulties. This patient is the only one in this series of 101 in whom an advanced lesion in the femur was not associated with widespread lesions in other bones.



FIG. 25.—Right femur.



FIG. 26.—Left femur.

Except for the preceding two citations and for invasion by direct extension to ribs underlying the cancerous breast we believe lymphatic permeation is responsible for the bone metastases in our 101 cases.

The route of invasion to the shoulder girdle, we believe, is by way of the axilla. Cancer cells from the breast may reach the axilla either slowly by lymphatic permeation in the breast (Fig. 30) and along the deep fascia of the chest wall (Fig. 31), or more quickly by lymphatic embolism to the lymph

nodes and secondary permeation beyond them to reach the bones of the shoulder girdle. Before the days of the X-ray, Handley<sup>2</sup> evolved the theory of extension to the humerus taking place by permeation along the lymphatics lying just beneath the skin and fat and extending from the breast out over the shoulder and down the arm as far as the deltoid insertion to reach the humerus. This route may apply in certain exceptional cases in which the

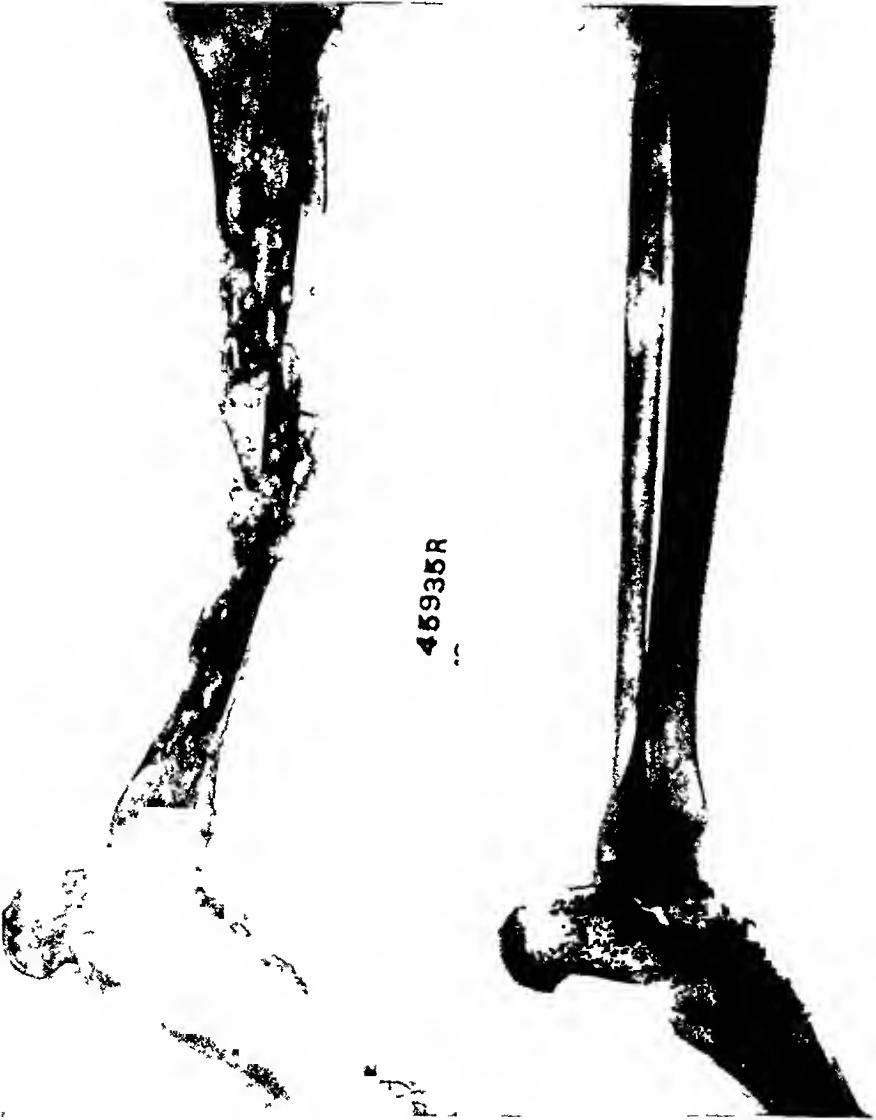


FIG 27—Right leg and foot showing invasion of all bones

FIG 28—Metastases in left tibia, fibula, os calcis and astragalus

first invasion of the humerus appears below its head and neck. In his most recent paper on bone metastasis Handley<sup>3</sup> concurs in our view that the usual route is deep to the pectoral muscles rather than superficial to them.

The metastases to the shoulder girdle in fifty-four of our cases were bilateral in twenty-four, homolateral only in twenty-three, and contralateral only in seven. Radical breast amputation had been performed on four of

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the bilateral cases, fifteen of the homolateral and four of the contralateral. The occurrence of metastases only in the shoulder girdle contralateral to the breast cancer might be explained by the operation on four having excised all

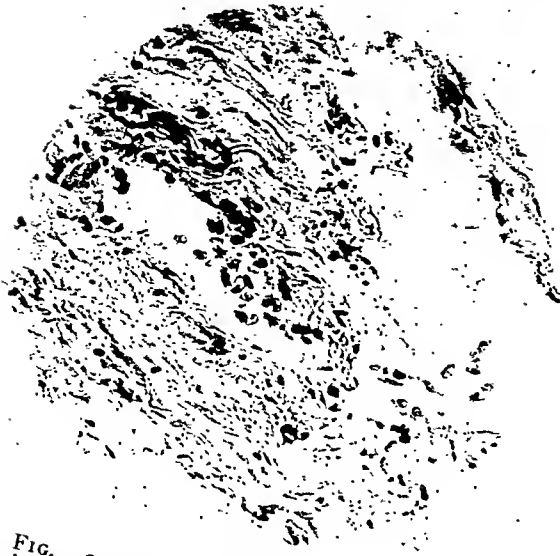


FIG. 29.—Posterior parietal peritoneum showing cancer cell permeation of lymphatic vessel running diagonally across middle of photo-micrograph. Courtesy of Dr. W. P. Belk.

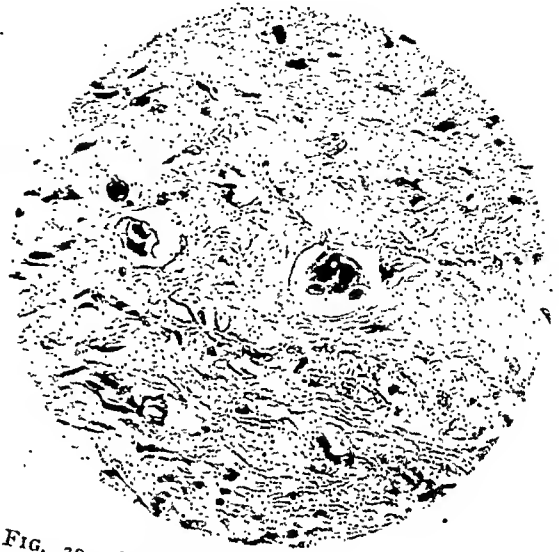


FIG. 30.—Breast tissue at a distance from the primary tumor. Permeated cancer cells shown in the cross section of two lymphatic vessels. Courtesy of Dr. E. A. Case.

of Handley's <sup>2</sup> microscopic growing edge of permeation in the direction of the homolateral axilla and having failed to excise it toward the contralateral axilla. Contralateral invasion only in the three non-operative cases suggests



FIG. 31.—Subcutaneous tissues of chest wall. Longitudinal sections of several lymphatic vessels containing permeated cancer cells. Courtesy of Dr. Herbert Black.



FIG. 32.—Meninges and brain. Longitudinal and cross sections of several lymphatic vessels showing permeated cancer cells. Courtesy of Dr. N. W. Winkelman.

the possibility of the lymphatics to the homolateral axilla having been blocked by abnormality or disease preceding the cancer. By permeation upward from the axillary lymphatics cancer cells can be conducted to the lower cervical vertebræ first, and later to the upper cervical

and finally to the skull, dura (Fig. 32) and brain. We have not made any special observations bearing on the lymphatic permeation which causes widespread invasion of the ribs.

We have repeatedly seen chains of cancerous tubercles along the course of the lymphatics in one or more of the third, fourth and fifth interspaces on the pleural aspect of the chest wall leading backward to the third to sixth thoracic vertebræ. The cancer cells may gain entrance to these intercostal lymphatics either (*a*) by direct extension from the breast through the chest wall or (*b*) by lymphatic permeation or embolism to the lymphatic nodes lying along the internal mammary artery.

Vertebral metastasis may remain confined to the one or few vertebræ first affected but more commonly the metastases extend more widely and frequently involve the entire spine. Because of the absorption of lime salts it is often difficult to obtain good röntgenograms of the spine (Figs. 10 and 23). This difficulty is further enhanced by crumpling up of the bodies of several vertebræ in many of the very late cases. Compression of the bodies of one or several vertebræ with or without angulation of the spine may, but seldom does, cause paralysis by pressure on the spinal cord. More commonly spinal paralysis, even when sudden in onset, is due to metastases growing in the epidural space<sup>4</sup> and may then be overcome in some cases by vigorous irradiation.

The roots of the spinal nerves may be either compressed by secondary cancer of the bone or, more often, of the soft tissues, or actually invaded by cancer cells giving rise to widely distributed pain and tenderness in the areas of distribution of the affected nerves (Case II) irrespective of whether or not the bones underlying the pain areas have been invaded by cancer. The pain and tenderness of spinal nerve irritation are often erroneously ascribed to an underlying bone metastasis. Patients commonly exhibit evidence of quite as much tenderness on pinching of skin, fat and muscle as they do on making a corresponding amount of digital pressure against the bone, regardless of whether the latter is invaded or not. We have exceptionally found unmistakable evidence of tenderness in metastatic bone lesions. Spinal nerve irritation often causes pain and tenderness in the anterior abdominal wall where they are all too commonly and wrongly blamed on one or another intra-abdominal lesion. These pains are often relieved by irradiation over the spinal origin of the affected nerves.

In order to explain our views pertaining to metastases of the lumbar vertebræ and the bones of the pelvis and lower extremities it will be necessary to digress for a few moments from a direct description of lymphatic channels leading to the bones.

We attend the autopsies on our breast cancer cases and some of our observations on evidence of lymphatic permeation within the abdomen seem worthy of mention particularly as some of them have a definite bearing on metastases to bones below the level of the diaphragm.

Concerning the method of extension of cancer cells within the abdomen secondary to breast cancer we differ both from the generally accepted view that they are due to blood-stream emboli and from Handley's view<sup>2</sup> that they are due to "transcœlomic transplantations."

Excluding the cases which die of some intercurrent disease before the breast cancer has run its course we find extensive evidence of intra-abdominal lymphatic permeation in over 80 per cent. of cases autopsied.

A fairly constant finding, but one easily overlooked if special search is not made for it, consists of enlargement and induration of the lymph nodes along the abdominal aorta, the common iliac arteries, often also along the internal and external iliac arteries and much less frequently along the femoral arteries into the saphenous and inguinal regions. Microscopic examination may reveal cancer in this entire chain of lymph nodes, but more commonly cancer is found only as far down as the deep inguinal nodes and not in the superficial inguinal and saphenous nodes even though the latter be enlarged. These enlarged lymph nodes are certainly not due (1) to transplants as they lie under the posterior parietal peritoneum and there is usually lacking a lesion of the peritoneum from which cancer cells could be brushed off to form the transplants; (2) to lymphatic embolism because (*a*) the lymphatic current is in an upward direction, and (*b*) they are often found in the absence of any other pelvic or lower abdominal metastasis; nor (3) to blood-stream embolism because it is inconceivable that emboli should so habitually involve this entire chain of nodes—often in the absence of other noteworthy abdominal metastases (Case II). Microscopic examination of the lymph channels associated with these nodes commonly shows extensive lymphatic permeation (Fig. 29).

Cancer cells from the breast may reach these deep lymphatic channels and nodes (1) by permeation downward from the chest along the aorta when cancer from the breast has invaded that cavity early, usually by lymphatic permeation; (2) by lymphatic permeation as described by Handley<sup>2</sup> along the deep fascia of the chest wall and through Handley's "dangerous epigastric triangle"<sup>2</sup> to reach the lymphatics of the anterior parietal peritoneum, from which point we have occasionally seen cancerous tubercles studing the peritoneum either (*a*) along the anterior, lateral and posterior parietes or (*b*) along the diaphragm, to the aortic region; or (3) by permeation through the lymphatics from the breast along the deep fascia to penetrate the abdomen in the lumbar region as described by Handley<sup>2</sup> but not recognized in any of our cases.

Often the enlarged lymph nodes as described constitute the major or, aside from the liver, the only (Case II) macroscopic evidence of intra-abdominal cancer. When the abdominal metastatic lesions are somewhat further advanced discrete tubercles will be found usually first in the mesojejunum and these tubercles are largest at the root of the meso and diminish in size toward the jejunum. The first nodules to appear in the jejunum are at its mesenteric attachment and they are older and larger than the nodules

finally appearing on its anti-mesenteric aspect. These mesenteric nodules are covered by peritoneum; hence are not transplants and their distribution is too constant to be explained by vascular emboli. They appear first in the mesojejunum, apparently because the lymphatics in this structure are permeated earlier from the aortic lymphatics than are lower lying mesenteries and mesos.

At a somewhat later stage nodules of the same type may be found widespread in or on mesentery, mesos, and large and small gut and under the parietal peritoneum, which latter at first can be slipped back and forth over them. This applies in some instances we have seen in the deposit at the bottom of the cul-de-sac (in cancer either of the breast or of the stomach) so commonly regarded as always being due to transplantation but being under the peritoneum must, in these cases if not all, be due to permeation.

In their latest stage these nodules may invade the covering peritoneum and project above it and therein resemble transplants which at first are always suprapерitoneal but growing inward they may invade the peritoneum. When nodules have reached this stage we not infrequently uncover entirely similar nodules in various places, as, for instance, within the area of fusion between large gut and posterior parietal peritoneum, which are entirely inaccessible to transplants. We have only very rarely seen nodules superimposed on peritoneum in the manner to be expected from early transplants. For these and other reasons we believe the dominant process of dissemination of breast cancer cells within the abdomen is lymphatic permeation. Those who do not believe the theory of lymphatic permeation of cancer cells should study the excellent examples of it in the slides of the brain, lung, pericardium, and adrenal gland shown by Dr. George M. Robson<sup>5</sup> in a cancer other than of the breast.

The aortic and iliac lymph nodes and main channels lie in intimate contact with the lumbar spine and sacrum, and collateral lymph channels extend to the lowermost ribs and bony pelvis. Permeation apparently takes place with great rapidity down these channels in a direction the reverse of the normal lymph current and gives rise to metastases in the lumbar vertebræ, lower ribs and pelvic bones.

Handley<sup>2</sup> originally expressed the opinion that metastasis to the femur was due to cancer cells permeating through the lymphatics lying on the deep fascias of the anterior chest and abdominal walls and penetrating the femur at the great trochanter. Years ago we were impressed by the absence of cutaneous and subcutaneous nodules overlying these lymphatics in patients having extensive invasion of the bones of the lower extremity. Handley's theory as to the route of extension would have been more plausible had superficial nodules as described in our Case I been a frequent finding in association with metastases to the upper and lower extremities. In our six cases showing metastases below both elbows and below both knees and in another case having metastases below the knees but not below the elbows there were no skin nodules in three (including our Case II) of them. One

developed a few skin nodules in the immediate vicinity of the primary tumor a few weeks before death. In another patient superficial nodules extended from the angle of the jaws down the back to the buttocks and down the chest and abdomen to the upper anterior third of the thighs. Another patient was our Case I, who presented the most extensive skin nodules that we have seen anywhere. Handley<sup>2</sup> states that skin nodules never extend below the middle of the upper arms nor below the upper thirds of the thighs but our Case I exceeded both those limits. The seventh patient was a post-operative case, described in detail elsewhere,<sup>6</sup> who developed two nodules near the umbilicus a few weeks before death. The very late development of skin or subcutaneous nodules similar to hers over either the chest or abdomen in post-operative cases is commonly ascribed to cancer cells lying dormant, locally enclosed in fibrous tissue. We surmise, however, that many of these cases, especially in the presence of extensive visceral metastases, are due to cells permeating from within outward through the wall of the chest or abdomen. The complete modern breast operation, especially along the lines laid down by Handley,<sup>2</sup> supplemented by irradiation, is seldom followed by external recurrence. In these days patients exhibit skin nodules far less frequently than bone metastases.

When we found that röntgenograms of our early cases showed the first invasion occurring most commonly in the head and neck and only exceptionally lower down in the femur we searched for another route and discovered the chain of cancerous lymph nodes and permeated lymphatics which we have described as lying along the main abdominal blood-vessels. It is our belief that the usual route of invasion of the femur is by permeation along these intra-abdominal and intrapelvic lymphatics and thence along lymphatics in the ligamentum teres. We think Handley<sup>2</sup> was unduly influenced by finding six homolateral to two contralateral cases of metastases to the femur in his early material and our views thereon have been expressed elsewhere.<sup>6</sup> In our present series of cases the femoral metastasis was bilateral in twenty-seven, homolateral in two and contralateral in three. In his recent paper Handley<sup>3</sup> expresses approval of the route we describe. After the cancerous invasion of the femur gradually extends downward, permeation of the lymphatics of the soft tissues overlying the knee-joint occurs sufficiently early to produce X-ray evidence of metastasis at or near the upper end of tibia before it is shown in the lowermost femur. Similarly, permeation of lymphatics of the soft tissues carry cancer cells from the shaft of the humerus to the upper radius usually before the lowermost end of the humerus shows involvement by X-ray.

In our opinion the relative infrequency of metastasis in the bones below the knee and elbow is not due to the rather prevalent opinion that these bones possess some form of special immunity, but is due to death occurring from extensive cancer metastases before sufficient time has elapsed for the slow-moving lymphatic permeation to reach these distant bones. Were the average duration of life after the onset of bone metastasis one or two



years longer invasion of all the bones down to the terminal phalanges of the fingers and toes would be fairly common.

For practical purposes it may be assumed that if skiagrams of ribs underlying the breast, of the shoulder girdles, of the spine from the mid-cervical region to the sacrum and of the pelvis fail to show metastasis then bone metastasis is not likely to be found elsewhere. The exceptions to this statement are the cases similar to our Case II in which vascular emboli are carried early to distant bones. This occurrence is too rare to justify taking skiagrams of the entire skeleton in the search for a bone metastasis that might contraindicate operation. Any otherwise unexplained pain in a bone, however, does call for special skiagrams of it.

We cannot predict which one or more of the lymphatic routes to skin and fat, to bones, or to thoracic or abdominal viscera, permeation will elect to follow in any given breast case but once we obtain evidence of permeation having started on one or more routes we can make a reasonably accurate prediction of the metastatic deposits that will follow and this we could not do if blood-stream were the main factor in disseminating cancer cells.

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## OSTEITIS FIBROSA\*

CASE REPORTS SUGGESTING A TRAUMATIC ORIGIN

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THE multiplicity of names given to bone tumors of the giant-cell and fibroblastic group attests to the uncertainty as to their etiology and to the extreme diversity of histological appearances presented. Cases bearing a singular similarity to one another have been designated osteitis fibrosa cystica, osteodystrophia juvenilis, osteodystrophia fibrosa localisata, giant-cell tumor, bone cyst and chronic fibrous osteomyelitis. The general acknowledgment of a single etiological theory for the entire group would set some of this chaos in order. We propose to outline a conception of the disease based upon the fundamental hypothesis of a primary trauma to the bone. Such a conception affords a basis for grouping several supposedly distinct pathological entities as consecutive phases of a single disease process. Moreover it provides a plausible explanation for otherwise irreconcilable clinical and röntgenological phenomena.

A generalized form of fibrosing osteitis was described by von Recklinghausen and bears his name. The localized form to which this discussion is limited has received subsequent recognition. Bloodgood was a pioneer in emphasizing the benignity of giant-cell tumor and advocating conservative treatment. To this date, however, the appellation of giant-cell sarcoma (Ewing) retains for it the suggestion of malignancy. Several recent attempts have been made to draw into a single category previously distinct but interlocking bone dystrophies. Garland, for example, incorporates into a single group osteitis fibrosa cystica, osteitis deformans (Paget's), osteomalacia, giant-cell tumor and bone cyst. By all odds, the most comprehensive and brilliant presentation of the subject from a pathological viewpoint is the recently published study of Geschickter and Copeland. They have painstakingly reviewed over 400 cases of tumors of the giant-cell group, including giant-cell tumor, osteitis fibrosa, solitary bone cyst, epulis and xanthoma, together with several intermediate "variants." The conclusion drawn is that the first three named are stages in a single process and have the common primary factor of trauma. This presentation is in accord with this view. We have borrow liberally from their writings in elucidating the transitions from one stage of the pathological picture to another. In appropriating the theory promulgated by Geschickter and Copeland, we have added nothing to their masterful discussion of the pathological processes involved. However, in contributing our confirmatory evidence gathered from clinical obser-

\* Read before the conjoint meeting of the Philadelphia Academy of Surgery and the New York Surgical Society, February 13, 1930.

vations, we are compelled to admit certain slight modifications of the original thesis of these authors, in order to bring the theory into close conformity with clinical facts.

*Inflammation.*—There are many arguments against an infectious origin. In the first place, cultures taken at operation are uniformly sterile. Phemister, who regards the condition as inflammatory, was able to cultivate a staphylococcus in a single instance but could not exclude a skin contamination. Moreover the histological picture is not that of an infiltrative reaction to bacterial invasion. Small round cells are conspicuously absent. The stage in the process which will be subsequently described as subcortical hæmatoma formation is illuminating. Arguing from an analogy of the behavior of hæmatomata in general, the presence or absence of infection will determine subsequent developments. If the blood clot is infected, there will be cellular invasion, degeneration of hæmatogenous coagulum, and eventually suppuration. However, in not a single recorded case has suppuration been observed either superficially, subperiosteally or within the medulla. In the absence of infection the blood elements will be gradually replaced by fibrous tissue. It is the latter course which is pursued by the disease under consideration. Furthermore, the symptomatology is not that of an infection. There are two major symptoms, namely, pain and swelling. Pain may result from distention of the richly enervated periosteum if, as in Case IV, the lesion be peripherally placed. Otherwise the disease runs a relatively painless course until attention is directed to swelling over the bone or the occurrence of pathological fracture (Case I). Some cases, indeed, are discovered only by an incidental röntgenological examination. Finally, the clean healing following fracture or operative incision provides an additional bit of evidence against infection. Such healing could not occur with regularity in an infected bone.

*Neoplasm.*—The lesion certainly does not behave as a malignant growth. Its only malignant characteristic is a tendency to mild recrudescence or perhaps recurrence. If neoplastic at all, it must be quite benign. However, its cellular morphology discloses neither a hyperplasia of tissue normal to the region involved nor an overgrowth of abnormal embryonic elements as in the blastomata.

*Trauma.*—This provides the most likely explanation for the disease. It is noted in the preponderant number of case histories. Its absence from the history, moreover, is not exclusive since many cases are in children and the slight injury necessary may readily pass unnoticed by unobservant adults. Certain features are very significant. The bones most often affected are: the humerus near the greater tuberosity, the radius at the lower end, the tibia at one or the other extremity, and the femur near the greater trochanter. These are likewise the common sites of injury in children. The portion of the bone involved is also characteristic. In children it is always on the metaphyseal side of the epiphysis. In adults it may be primarily in the shaft or have assumed this position secondarily as a result of growth in the

length of the bone. Case IV represents an adult of the first class with a history of recent trauma over the tibia. The rarefaction seen in the X-ray is near the cortex. There is periosteal proliferation on the external aspect and eburnated bone on the opposite side of the lesion. On the other hand, a lesion, originating near the epiphysis and shifting with the growth of the bone prior to discovery, would be expected to occupy the central medullary portion of the shaft. Accordingly the respective ages of the patient at the time of injury and at the time of observation together with the length of the intervening period are all factors to be considered in interpreting the changes encountered in a given case.

A traumatic origin appears to explain adequately the sites of election of the lesion. It likewise reconciles the divergent histological changes encountered by interpreting them as consecutive phases of a single pathological process and not as distinct entities. The sequence is somewhat as follows: A child sustains a trauma to the bone at one of the favorite sites previously mentioned. Hæmorrhage occurs within the cortex. The blood, seeking an outlet, finds it most readily in the cancellous tissue producing a juxta-epiphyseal hæmatoma. The next step is well described by Geschickter and Copeland. It is concerned with the giant-cells whose function in ossification of callus (represented by the hæmatoma) or preëxisting cartilage is an osteoclastic one. They push their way from the cortex into the central portions, blazing a trail for new vascular channels. Normally their excursions are limited by surrounding fibroblastic proliferation. In this instance the latter has been crippled by interference with the blood supply of the overlying periosteum. The result is an imbalance of the normal mechanism of osteogenesis—"fibro-ostosis" by fibroblasts on the one hand and osteoclasia by giant-cells on the other. The latter get out of hand and the so-called giant-cell tumor results. In certain cases such an imbalance does not exist. Instead the more normal fibroblastic replacement occurs. Such a response with fibrous replacement is encountered in the shaft where a thick cortex affords restraint. Giant-cell hyperplasia occurs near the metaphysis where cartilaginous tissue and cancellous bone abound. If the former course is followed with resultant osteitis fibrosa, cysts may or may not be found, depending upon the degree of degeneration. In the further alterations in morphology, the rigid shell of cortical bone surrounding the lesion exerts its influence. Nature is not able always to fill the entire space with fibrous tissue. In such cases there is only a fibrous envelope, the central portion being filled with semifluid material or blood. Thus the final stage is the solitary bone cyst.

One fact remains to be explained. The maximum number of bone cysts occur prior to the twentieth year. The favorite age incidence of giant-cell tumor is the decade immediately following. According to the sequence just outlined, this is difficult to understand. Ewing, however, states "a history of trauma and the presence of hæmorrhage and pigmentation in the walls of the cysts seem to show that the presence of blood coagulum influences the

development both of cysts and of giant-cells." It is quite possible, therefore, that bone cysts may arise in many cases directly from the hæmatoma by cystic softening without the intermediary phases of giant-cell tumor or osteitis fibrosa.

*Operative findings.*—Exposure of the lesion at operation may disclose either one or two appearances. There may be an elevated eburnated cortex overlying a hæmogenous area of soft brownish tissue. On the other hand, removal of a thin bony shell may reveal an encapsulated cystic growth, comprising fibrous wall and fluid or semi-liquid contents. In the latter case the entire lesion may be readily stripped from its nest in the bone. The trabeculation often seen in X-ray photographs suggests a framework of interlacing osseous fibrils. This is not encountered in the lesion. The X-ray appearance is due actually to inequalities in the thickness of the overlying cortex and not to trabeculation of the growth.

*Treatment.*—In addition to X-ray therapy and operation, spontaneous healing following pathological fracture must be taken into account. The last is to be regarded purely as a decompression. Operation also serves to decompress but permits at the same time, of extirpation of abnormal tissue. Irradiation aims to retard abnormal tissue growth. In the light of our experience, any single method of treatment may be inadequate. In the first case, an apparent arrest by fracture later required X-ray treatment for a recrudescence of activity. The second case showed reactivity after an operation of supposedly total extirpation. The third patient improved temporarily under irradiation but subsequently required operation. He further illustrates the danger of interference with bone growth incident to prolonged irradiation over an epiphysis.\* The failure of any single method to effect a cure in every case indicates that a combination of operative and X-ray treatment approaches nearest to the ideal, at least in the present state of our knowledge of the condition. The tendency to reactivity or recurrence makes it imperative to keep patients under continued observation.

CASE I.—Boy, aged seven years, admitted to University Hospital March 2, 1925. The history was completely negative prior to a fall while at play on the day of admission. Resultant injury to left arm shown by X-ray to be a fracture of surgical neck of humerus at site of a giant-cell tumor. Dressing applied. X-ray three weeks later showed normal healing. X-ray taken January 27, 1926, showed some increase in size of lesion and three courses of X-ray treatment were given during the year. There was no disability at this time or subsequently. The picture on September 16, 1916, showed considerable bony deposition but a superficial "blister" producing a periosteal bulge. After the third course of treatment, January 13, 1927, the bone appeared solid. At this time the shifting of the site of the lesion away from the metaphysis as a result of bone growth was very evident. At a final examination, four and a half years after the original fracture, October 27, 1929, the bone was completely calcified and the lesion appeared to be healed.

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\* Our attention has been called to a case in the files of the Roentgenological Department of the University Hospital in which apparent interference with bone development has occurred from the growth of the lesion alone as the case had not received irradiation. This is a question which will require further investigation.

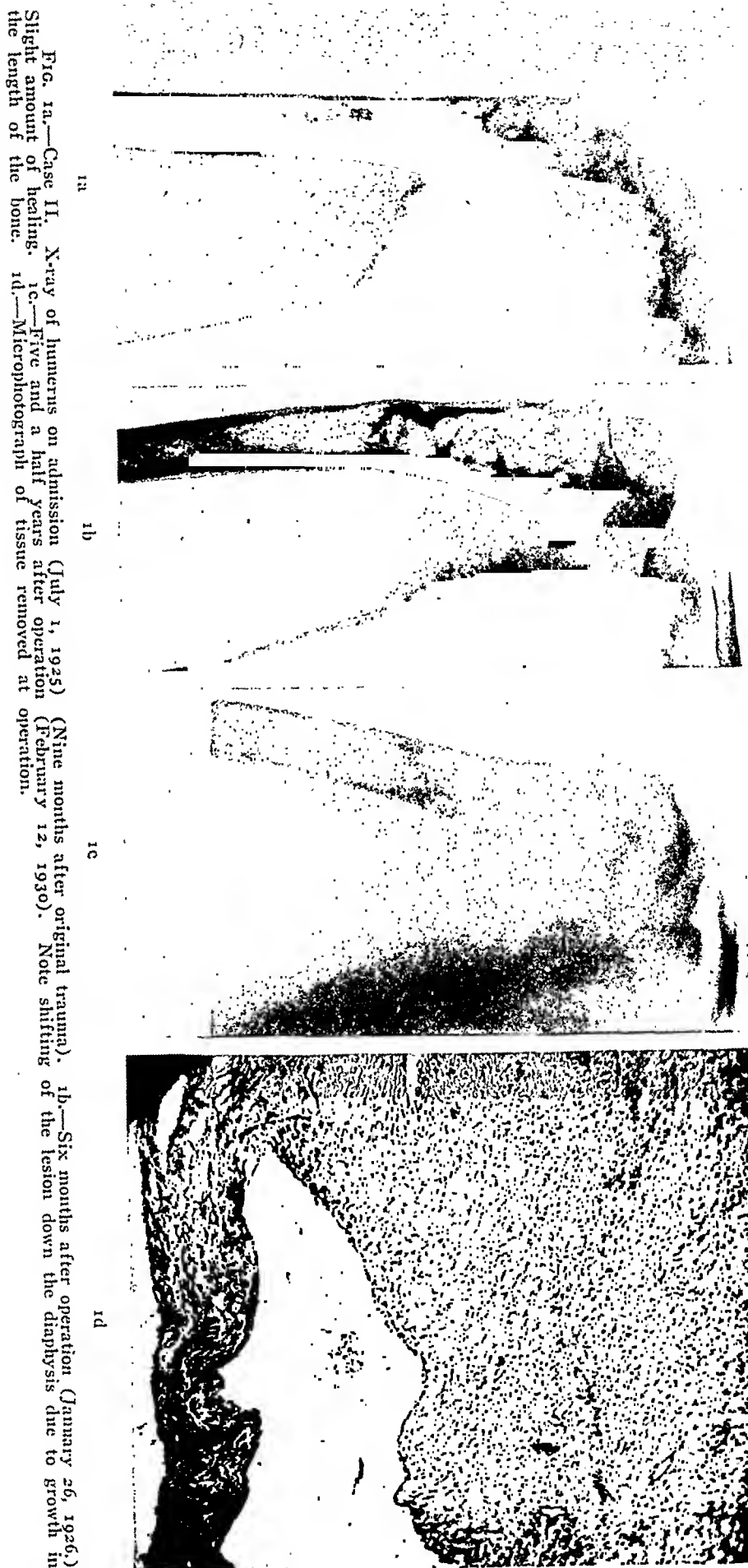


Fig. 1a.—Case II. X-ray of humerus on admission (July 1, 1925) (Nine months after original trauma). 1b.—Six months after operation (January 26, 1926.) Slight amount of healing. 1c.—Five and a half years after operation (February 12, 1930). Note shifting of the lesion down the diaphysis due to growth in the length of the bone. 1d.—Microphotograph of tissue removed at operation.

Case II.—Boy, aged 7 years, fracture (?) upper right humerus, October, 1924, caused by toy engine thrown by playmate. Two months later a fall upon the same arm caused a great deal of pain and a "growth" was noted on the arm. No further symptoms. Admitted to University Hospital July 3, 1925 for investigation of tumor. X-ray diagnosis, "Osteitis fibrosa cystica of upper right humerus." Left humerus, pelvis and femora normal. Operation, July 8, 1925, gas anæsthesia. Periosteum elevated and a very thin cortex opened. The lesion appeared to be a cyst with fibrous wall and fluid contents. Entire wall removed intact after evacuation of contents. Bone dust, obtained from a cranial operation in process at the moment, was introduced into the defect in the bone. Periosteum sutured. Wound closed without drainage. Pathological sections of tissue removed showed for the most part fibroblastic tissue. There were several areas, however, showing typical giant-cells. These cells were in the neighborhood of cartilage. Cultures were not made. X-ray, August 27, 1925, "Apparently new bone formation or



FIG. 2a—Case III X ray of humerus one week after injury. Note the eccentricity of the lesion (February 26, 1928). 2b—After operation (January 28, 1930) showing new bone formation and bone chips introduced into the cavity.

calcified blood clot." Five months later, January 26, 1926, firm bony union with no disability at the shoulder. Boy had played football in the meantime. X-ray showed no increase in the area of upper right humerus but there was only a slight amount of healing. Final examination five years and four months after original, February 13, 1930.

CASE III.—Boy, aged eight years. Injured by fall in which he struck shoulder against radiator. Pain was gone the next day. One week later mother observed an inability to raise the arm and a swelling over humerus, and had the boy X-rayed, May 26, 1928. The report was giant-cell tumor of upper right humerus. Irradiation was begun and continued at intervals for eighteen months. During this time there were no symptoms and the swelling diminished in size. Several X-ray examinations indicated improvement. On November 29, 1929, a new area of rarefaction was apparent below the upper end of the diaphysis. In addition it was noted that there was five-eighths of an inch of shortening of the arm. Operation was determined upon. This

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was done January 3, 1930, under gas anæsthesia. The cortex was thin. A well-encapsulated cyst containing bloody fluid was removed intact. Chips of bone from the removed cortex were dropped into the cavity after light curettage. The periosteum was sutured and the wound closed without drainage. Healing was perfect. The pathological sections showed no growth. Pathological sections were reported as showing mature fibrous tissue with degenerative change which might have been due to X-ray therapy and increased vascularity. *Diagnosis.*—Osteitis fibrosa crystica. X-ray examination January 28, 1930, showed some new bone formation.

CASE IV.—Woman, age thirty years, injured by fall, May 9, 1929, in which she

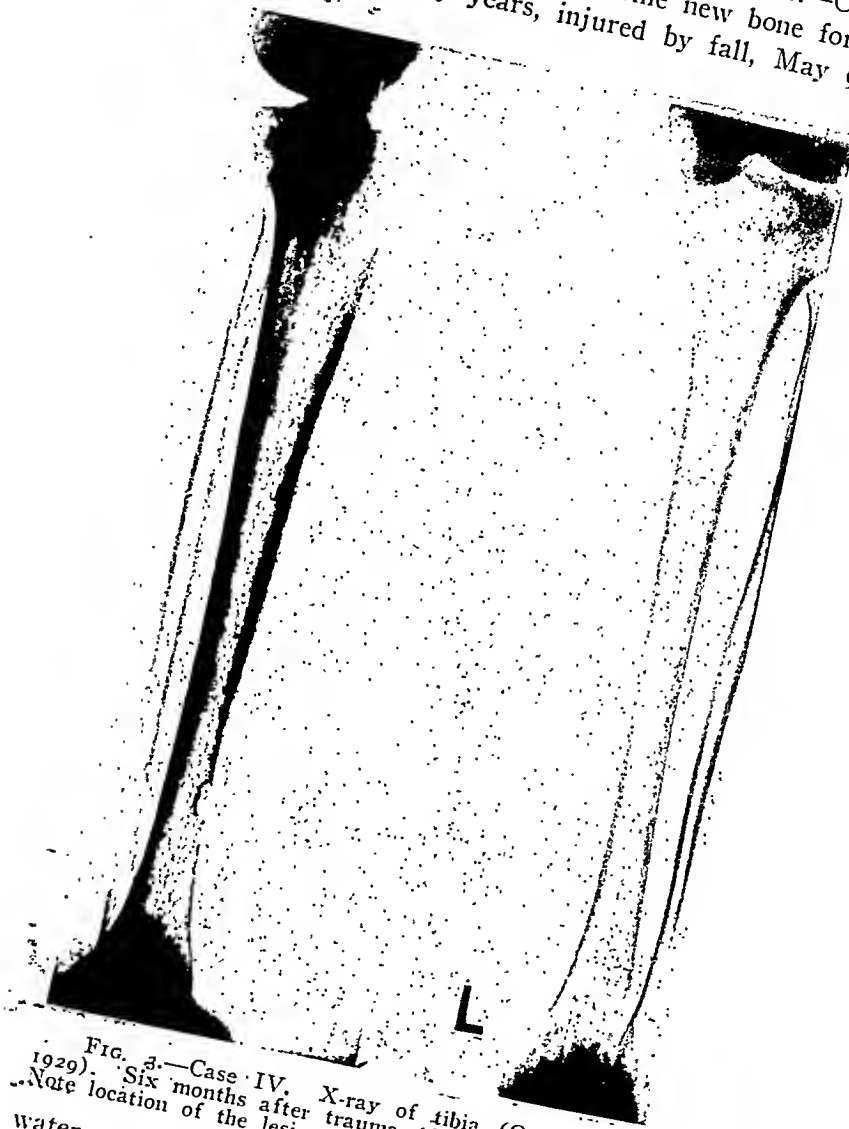


FIG. 3.—Case IV. X-ray of tibia (October 31, 1929). Six months after trauma (October 31, 1929). Note location of the lesion in the shaft (adult form).

caught her toe in a water vent and struck her tibia against the curbstone. The limb was not X-rayed at the time. Continued pain at site of trauma from time of injury until admission to the University Hospital October 30, 1929. During the interval she was X-rayed in three different hospitals, the first plate being taken six weeks after the injury. A review of these films showed no evidence of fracture at any time but a circumscribed area of rarefaction which slowly increased in size and was thought to be due to osteomyelitis. The patient had refused operation previously but its identity was on November 6, 1929. Our röntgenologist reported the rarefied area previously noted and commented that it did not look like a localized osteomyelitis but its identity was uncertain. The blood Wassermann was negative. Operation under nitrous oxide disclosed a bulging periosteum and an eburnated thickened cortex. Beneath this there was an irregularly formed cavity containing soft brownish granular material. This was



removed with a curette and the cavity saucerized. Gauze packing in the wound. Culture was not taken. The pathologist reported whirls of mature fibroblasts, increased vascularity and some areas of mild round-cell infiltration. The pathological diagnosis was osteitis fibrosa cystica. Examination January 20, 1930, revealed good healing of wound, no pain. X-ray at this time was reported negative.

CASE V.—Girl, aged 2 years. The child's mother had noticed a tendency to drag the left leg in walking during the past six weeks. Examination showed a fullness and tenderness below the greater trochanter with a painful limitation of hip-joint motion. X-ray report: "Lesion involving the upper end of the left femur. It shows a marked



FIG 4—Case V. X ray of femur before operation.

rarefaction with trabeculation and some expansion of the cortex *Diagnosis*—Possible giant-cell tumor."

*Operation*: February 21, 1930—Thin flexible shell of bone opened exposing a cavity the size of a pigeon's egg. The cavity was lined with a fibrous membrane and filled with bloody fluid. The capsule was removed intact. The cavity was curetted and allowed to fill with blood.

*Pathological Report*.—Osteitis fibrosa cystica.

The patient is still in the hospital at the time this report is made.

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# THE CURABILITY OF CANCER\*

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I HAVE thought it might be agreeable to you to speak of the brighter aspect of the usual dark picture of carcinoma. Accordingly I have culled from the records of the Follow-up Department of the Lankenau Hospital a few cases that may be of interest from the standpoint of the curability of cancer.

Before proceeding with my recital, however, let me say that curability of cancer depends on early detection, early treatment, site of the tumor, its nature, presence or absence of metastasis and finally on constitutional peculiarities of the individual concerned. Some day perhaps we shall know about the last-named factor in particular and the other factors in general. Some day we may know something about early cancer and at what stage metastasis begins. Indeed it is entirely possible that we may have a routine test for detecting early cancer and thus make a forward stride in the curability of cancer. We may then know why, as occasionally happens when a woman presents herself within forty-eight hours or even twenty-four hours after first noticing a lump in the breast, axillary metastasis can already be detected. There is no question in medicine that demands and is getting more attention and more intensive study than the question of the how, why, and whither of tumor formation.

Cancer is always considered a disease of middle life, that is, as occurring beyond the fifth decade, although it is not unusual to observe it before that period. When it does develop earlier, however, it usually runs a rapidly fatal course. Like all rules, this has its exceptions. Let me cite two encouraging examples.

CASE I.—(Hosp. No. 3245/21.) Male, aged thirty-four years. Admitted November 2, 1921. Operation November 5. *Large carcinoma at pyloric end of stomach.* Subtotal gastrectomy done. Pathological report: "Mucoid carcinoma." For three years prior to admission, patient had suffered from digestive trouble, often seeking medical advice for same. Four months before admission, began to lose weight and strength very rapidly. Required blood transfusion (at another hospital) two weeks before admission to the Lankenau Clinic. In the eight years since operation he has been seen at intervals of six months and at each visit reported excellent health, no digestive trouble except when over-eating.

CASE II.—(Hosp. No. 626/23.) Male, aged forty-four years. Admitted February 25, 1923. Operated March 7, that is, six years ago. At that time, gave a history of eight years of periodic attacks of indigestion lasting one month and then disappearing for several months. The rest of the syndrome was less typical of ulcer than this item so that a diagnosis of pyloric obstruction was made on the basis of X-ray reports and the usual test meal, etc. For the past three years, the most annoying feature of the attacks was nausea, vomiting of undigested food, sticking pain in the epigastrium, all coming

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\* Read before the joint meeting of the New York Surgical Society and the Philadelphia Academy of Surgery, February 13, 1930.

on about two hours after meals. Except for a rather distended stomach the physical examination was negative. Operation revealed an old duodenal ulcer surrounded by inflammatory tissue. Subtotal gastrectomy was done. Pathological report: "Carcinoma simplex." Patient has been seen at regular intervals and has never had any further trouble. At his last visit, December 11, 1929, a fluoroscopic examination was made, which showed good function of the new opening and an indefinite deformity of the contour of the stomach at the line of resection.

Several cases of cancer of the breast selected for their long post-operative history also illustrate the fact that cancer does not necessarily mean hopelessness.

CASE III.—(Hosp. No. 804/21.) Woman, aged fifty years. *Carcinoma of both breasts.* Sixteen months before admission noticed a slight sanguinopurulent fluid from left nipple. One week prior to admission noticed a slight lump and sense of pressure in left breast. Nothing noticed in right breast. On examination, the left breast presented a hard mass, size of an egg, in the center of the breast. Nipple was retracted and exuded blood during manipulation. No apparent axillary involvement. The right breast was somewhat harder than normal and had a crust over the nipple. Operation: Radical amputation of left breast. Simple amputation of right breast. Pathological report: "Left breast: ductal adenocarcinoma. Lymph nodes negative for metastasis. Right breast: very early medullary carcinoma and chronic cystic mastitis." Since operation the patient has never had the slightest complaint. She has been coming to the clinic regularly and at her last visit, eight years after operation, there was no sign of recurrence in either breast, she had good motion of both arms and was able to do her heavy housework.

CASE IV.—(Hosp. No. 2976/22.) Woman, aged forty-five years. *Tumor of left breast,* eighteen months' duration, gradually increasing in size, loss of twenty-five pounds in weight since onset of tumor. Examination showed a hard, movable, slightly tender tumor mass in left breast. Provisional diagnosis fibroadenoma. Shortly after admission there was a sanguinopurulent discharge from the nipple and slight shooting pain in the breast. Right breast normal. At operation a small mass, size of hen's egg, was removed from the left breast. The pathological report read: Papilliferous cyst adenocarcinoma. The patient was lost sight of for a while but returned to the Follow-up Clinic in 1928, six years and six months after operation, presenting a recurrent nodule in the operated breast. The nodule was excised together with scar tissue. Pathological report: "Small cell, small alveolar carcinoma." The patient has been coming regularly to the Follow-up Clinic at intervals of four to six months, the last visit being January 10, 1930. She is perfectly well and able to support herself by laundry work.

In a recent study of end-results of carcinoma of the breast before the establishment of the follow-up system, now in the tenth year, we found that of 100 cases taken at random, covering a period of about fifteen years, 13 per cent. of the patients were living and well ten or more years after operation. It is only logical to suppose that the number is actually greater than thus appears, for the replies included a number of instances of death from intercurrent disease or accident of patients who had survived operation for periods varying from two to eight or more years without recurrence.

We are apt to think of cancer of the cervix or the fundus of the uterus as among the most hopeless ones, but still we have a number of five-year cures to our credit. Of a total of 140 cases treated by operation and radium, operation alone, or radium alone, eight are living and well from fifty to

eighty-one months, *i.e.*, four to seven years after treatment. Here, likewise, we must not lose sight of those dying from intercurrent disease or accident, so that the actual figures are somewhat better than indicated by the 8 per cent. of cures of almost five years or more. Time does not permit an analysis of these cases as to the type of tumor, duration of symptoms before coming for treatment and general constitutional features of the various patients. All of these naturally have an important bearing on prognosis. However, the conclusion to be drawn from the series of cases of cancer of the uterus or cervix or both from which these figures are taken is that in our experience surgery either alone or followed by the application of radium gives better results than radium alone, and that the earlier the cases come, the better the chance of a cure or at least a prolongation of life in comparative comfort. Our experience with radium and X-ray in the treatment of cancer has not by any means been encouraging. I do not refer to squamous-cell carcinoma. Again, I am forced to say that with a few exceptions neither radiation nor X-ray in the after treatment of operated patients has been as satisfactory as many claim. It seems strange that there is a great difference of opinion between gynaecologists, radium and X-ray specialists and the general surgeon on this point. My thought is that the general surgeon who has a large experience in the treatment of all forms of cancer in different parts of the body is the better judge. As an instance of prolongation of life after surgery, let me cite the following:

CASE IV.—(Hosp. No. 2773/29.) Female, fifty-nine years of age. Was a patient in the Lankenau Hospital twenty years ago when a panhysterectomy was done for cancer of the fundus of the uterus. The patient remained well until six months before her present admission. At that time following, as she thought, strain of lifting, she developed a profuse yellowish vaginal discharge, and had lost fifteen pounds in weight in the past two years. The patient is a rather undernourished individual weighing 120 pounds. General health excellent. Appetite and digestion good. Physical examination entirely negative except the vagina which was small, and showed an erosion of the postero-superior wall, which bled easily on manipulation. Diagnosis of carcinoma of the vagina was made. Under gas-oxygen anaesthesia a tube of 50 milligrams of radium was placed crosswise in the upper part of the vagina and removed in twenty-four hours. This was done on October 28, 1929. When seen again December 10, the patient reported that there had been no discharge for several weeks after the radium treatment, but about two weeks ago there developed a watery yellowish discharge associated with pain low down in the abdomen on both sides. Otherwise, health is good. The patient was seen again on January 14. She then complained of backache and persistent yellowish discharge, more marked when moving about actively. Vaginal examination showed a perfectly smooth vagina. No further treatment indicated for the present.

CASE V.—Another instance is Hosp. No. 74/22. Woman, aged forty-five years. In 1918 (two years prior to the establishment of the Follow-up System) the patient had a complete panhysterectomy. The pathological report of the specimens showed benign conditions except for a papilliferous cyst and mucoid degeneration of one ovary. The patient remained well for two and a half years. Then she developed lower abdominal pain, backache, shortness of breath, constipation and urinary frequency. With these complaints she came for readmission three years after operation. Physical examination showed abdominal fluid and a fluid wave that was transmitted on palpation. Laparotomy was done. About 2,000 cubic centimetres of blood-stained fluid and gelatinous material

were removed from the abdomen. A diagnosis of metastatic carcinoma of the peritoneum originating in the pelvis was made. The pathological report read: "Gelatinous material containing many small nodules shows mucoid carcinoma." The patient has been seen regularly since then at six months' intervals. Progress was satisfactory for forty-six months. At this time the abdomen was again distended with fluid. This was removed by tapping. Six months later a hard, globular mass was present in the abdomen, but there was no sign of fluid. She then had a course of X-ray treatment for a period of one year, at the end of which abdominal measurements showed slight increase in size of the mass. The patient, however, felt well and has continued so until the present time. When last seen, January 10, 1930, twelve years after the original operation and eight years after the laparotomy, she was well, except for weakness due to a recent attack of illness diagnosed as myalgia. The hard mass was still present in the abdomen but had not increased in size. Patient was in excellent spirits and up to her recent illness had been doing all her own housework.

Very satisfactory results can also be reported with many cases of intestinal cancer. In fact I have in mind several on whom I operated as long as from ten to seventeen years ago who have remained well. Among these is a physician living in Philadelphia, who at the time of operation, July, 1914, was fifty-nine years of age. He had a tumor of the ascending colon. I resected the terminal ileum, the cæcum and the ascending colon. Pathological report, adenocarcinoma. The doctor is in excellent health in spite of his seventy-five years, never having had the slightest symptoms since his operation. And I have just heard from a gentleman on whom I did a resection of the colon for carcinoma fourteen years ago. He is enjoying excellent health and at present is traveling in California. He was fifty-seven years old at the time of the operation.

CASE VI.—And here is a case of *cancer of the rectum* in a young woman, aged thirty-two years, on whom I did a Kraske operation in 1926, preserving the internal and external sphincter. I saw the patient two weeks ago and she is entirely free from any symptoms of recurrence. Her bowels move freely without cathartics, and she is perfectly well.

Of the numerous methods of treatment at our disposal only two have given definite results. The first and foremost is surgery; the second is by radiation with X-ray or radium, neither of which has done the good they are commonly said to do. I speak advisedly and with feeling, especially with regard to radium. The cures that I have cited are surgical cures. And the cures have not been because of grading the tumor or because they have had X-rays before, during and after the operation or because of other things to which men of little experience give attention, but because of good, radical surgery done early. Since we may acknowledge that our surgery as a whole is good and since unfortunately for progress in this direction, it is about as radical as can be done, our attention must therefore be directed to the "come early" part. Now in the skin, or the breast or sometimes in the uterus, the signs of cancer are fortunately early and fortunately too, can be recognized by the patients themselves. We are teaching them to do this. But in other situations, as for instance the stomach, where it is so common, the early signs are such as to baffle the most astute clinician; indeed I may say there

are no early signs which are not also the signs of other things. Here is one place where research is urgently needed—to find means of diagnosing early internal cancers. We must tell our colleagues, the clinicians and especially the research workers, about this again and again, repeat it, emphasize it, show them the results of late diagnosis and ask them to work with and for us and the good of the patients. Encourage the investigators, stimulate them, help them with their problems, remembering that without them, surgery would not be the blessing it is today. Theirs is not the spectacular part of the field: too often they are unsung, even laughed at, always underpaid and often underequipped. But remember Pasteur, Virchow, Ludwig, Koch, Kendall, MacLeod, Banting and all the others. How many patients snug and secure in hospitals know what is being done in the laboratories for their safety? Indeed, many patients do not know what a laboratory is, but think it is a place to wash your hands, a lavatory.

If, then, the only cures of cancer have come from surgery and a few from radiation, how many do we cure? Judging by reports, quite a few, but I pay little attention to them unless they come from individuals or institutions where there is a follow-up service. Unfortunately we have so few of these. I would add to this that a follow-up service must not only exist but must have a very important qualification. It must be hard-boiled. It must give no one, and no procedure the benefit of the doubt. It must not let enthusiasm influence facts. And the cold, hard facts must be the foundation and framework of its reports. Then and only then will we see how many cancer cases we cure in the average run that come to us.

For my next remarks it matters little exactly what the percentage of cures is. We all know that in spite of the encouraging examples just cited, it is still too low for our peace and comfort of mind and for the trust our patients should have in us. So the answer is quite obvious—new knowledge and new methods must be discovered and this can be done by research and research alone. We, as surgeons, can probably help by taking careful histories, records, and observations and by final summations. But the kernel of the nut is for the pathologists, physiologists, biologists, chemists and many others. Where and how shall they begin? It may be of interest to you to know what is being done along these lines in the Research Institute of the Lankenau Clinic under the able direction of Drs. Stanley P. Reimann and Frederick S. Hammett. With the kind permission of the Chairman, let me read a brief outline prepared by Doctor Reimann on the status of their work:

“Some two and a half years ago, the late lamented Mr. Rodman Wanamaker built a Research Institute for the Lankenau Hospital and supplied funds for a small nucleus of workers in cancer research. How did we begin? My first statement was, that the one and only factor common to all kinds of cancer is cell division; not just growth in size which is a different story, but growth in number of cells. Obviously, this is the place to begin. Since mitosis is a moving process in which chemical molecules are in active change.

our workers made it their task to find out what these changes were. Experiments were made with plants since they are easier for these experiments than animals, and it was discovered that in the roots of plants sulphur was present in the nuclei of cells in mitosis and then that the sulphur must be present in a certain form combined with hydrogen. The chemists call the group 'sulphydryl.' Then this same substance was found in animals. Now in cells which are not in mitosis, the sulphur is present in an altogether different form. If this is true, then cells should divide and grow in numbers if they are given sulphur in the sulphydryl arrangement. This was soon found to be so, and plants, minute animals such as paramecia, tissue cultures, the tissues of rats, mice and humans, all started to grow when they were fed, so to speak, on the sulphydryl compounds which our chemists had made. Already we have had a practical demonstration of the principle thus discovered, by the fact that a number of stubborn wounds such as leg ulcer and bed sores were stimulated to rapid healing by the use of the compounds. The compounds used and the details of their use will soon be published in the *Journal of the American Medical Association*.

Further experiments during the past few months gave overwhelming corroborating proof of these findings and now justify the unequivocal statement: normal cell division takes place because sulphydryl is formed, and never takes place unless it is present.

The next step is plain to everyone: find the substance which normally stops cell division. That there is such an antidote is perfectly apparent. Otherwise wounds would never stop healing. Indeed children would never stop growing. Just a few more divisions of the cells in an adult human being would make him as big as an elephant, whose cells are no larger than those of humans, so of course he must have more of them to account for his size.

Naturally enough, our interest now centers in sulphur. What do we know of it except we eat it mostly as cystin and excrete it as sulphates? There is a chemical study of the first magnitude ahead of us, the beginnings of which are just appearing in the literature.

Now the points which I want to drive home in any discussion of the curability of cancer can be summed up in a few sentences:

(1) Present methods are inadequate.

(2) Research must be done for the discovery of new things.

(3) The kind of research which at present promises the best hope is the chemistry of the body which normally starts, stops and controls cell division. Whether we are right or wrong in our theory that sulphur is the key to the lock, the chemical method of attack must be developed. Even if it is shown in the future that a micro-organism causes cancer, which seems extremely doubtful, that micro-organism must perforce do it by starting cell division. We must know the metabolic activities of an organism in growth and then try to change them. We can change the body chemistry of acids and bases,

we can change oxidation by thyroxin, sugar metabolism by insulin, why not the equilibrium of cell division?"

And for all this work endowment funds are essential.

In conclusion, let me again emphasize the importance of research work in this serious problem. Much has been accomplished but our methods are still more or less empiric. For example, we apply radium with considerable success in some cases and none in others. Some patients do well after operation; others do not. Some women develop lymphatic œdema of the arm; others do not. All these are questions that require elucidation and will probably not be explained until the cause of cancer is discovered. These questions require study and study, and more study. The work is time-consuming and money-consuming and I should like to say to those who have wealth at their disposal that money devoted to fostering the study of this vital question will prove of greater benefit than even the most far-reaching vision can foresee at this time. I hope a word to the wise and intelligent philanthropists in our midst is sufficient.



# SPASMODIC TORTICOLLIS \*

INTERRUPTION OF THE AFFERENT SYSTEM ALONE IN THE TREATMENT

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SPASMODIC torticollis in its more aggravated form is one of the most distressing of physical ailments. Men are barred from public life and women are forced to lives of seclusion. Embarrassed always by the uncontrollable movements, they shun the streets, places of amusement, and social gatherings. It is well known that whenever attention is focused on the afflicted subject and whenever the subject is conscious of this, the movements are always aggravated. Probably no other infirmity of the body so effectively blocks the career of the afflicted or is a greater handicap to the enjoyment of life.

The time seems appropriate, therefore, that an effort be made to find a means of relief which will at once be effective and at the same time be accepted and approved by the profession. As we shall see, attempts have been made from time to time to control the spasm by surgical measures but up to the present one could hardly say there has been any generally accepted procedure. My interest in the subject has been aroused by the opportunity of operating within the past six months on four cases of spasmodic torticollis, an unusual number in this comparatively short period. And because the results of the method we have adopted seem promising, I venture to bring this subject to the attention of this meeting.

Since the days of the sixteenth century when the term "torticollis" was used first by the French physician, Rabelais, the clinical syndrome "spasmodic torticollis" has been a subject of dispute and discussion both as to its origin and its treatment. It would not be amiss, before discussing a means of surgical attack, to recall to mind some of the views maintained as to the causative mechanism of spastic conditions. As early as 1896, Anton<sup>1</sup> regarded chorea as being due to a deficient inhibitory mechanism in the nervous system, active on an extrapyramidal motor unit, and in 1897 Bonhöffer<sup>1</sup> claimed it to be a disturbance in regulation of afferent pathways. Stauffenberg<sup>1</sup> spoke of an extrapyramidal system, in which he included the frontal lobes, corpus striatum, thalamus, cerebellum and nucleus ruber.

We are not concerned in this discussion with spasmodic torticollis of peripheral origin or even with that of central origin, when the source of irritation may be in the cerebral cortex.

According to Foerster<sup>2</sup> by far the most common causes of spasmodic torticollis are lesions of the globus pallidus and corpus striatum. The extra-

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pyramidal corticofugal pathways pass through the globus pallidus to the muscles. Interruption of them leads to the so-called "pallidum syndrome" with its characteristic disturbance of motility, among them a rigid torticollis. Affections of the corpus striatum may be congenital or may develop later in life on the basis of a hereditary predisposition. They give rise to spastic conditions known as "striatal hyperkinesis," to which belong chorea, athetosis, etc. Torticollis of striatal origin is characterized by a slow and irregular, intermittent cramp of the head rotators.

The corpus striatum serves as an inhibitory apparatus of the thalamo-pallidary reflex arch. There is an uninterrupted flow of impulses from all sensory receptors of the body to the thalamus opticus, and these impulses would all be returned to the periphery via the globus pallidus, were it not for the inhibitory action of the corpus striatum. A preëxisting deficiency for this inhibitory mechanism, Foerster believes, is necessary for the development of spasmodic torticollis of any type.

The plasticity of muscles that have to do with the maintenance of posture Sherrington<sup>3</sup> believes to be dependent upon the integrity of the dorsal roots and on the basis of this, the theory has been advanced that muscle tonus is a proprioceptive reflex. The sensory impulses from a given muscle are alone responsible for the plasticity of that muscle.

Sherrington states that in decerebrate rigidity the tonic rigidity of a muscle is maintained when all the nerves to the limb have been severed except the nerves of the muscle itself. The rigidity of the muscles immediately ceases on severance of the spinal afferent roots, through which pass the afferent fibres from the muscle. It was on the basis of this observation that McKenzie<sup>4</sup> in 1924 suggested that the muscle spasm of torticollis might be effectively relieved by section limited to the posterior roots.

To Ranson<sup>5</sup> we credit the most extensive research into the dorsal roots in relation to muscle tonus. He not only reviews the literature of the subject from some of the earliest observations but reports the results of his own experiments on cats; a series in which the leg was completely de-afferented by section of the dorsal roots close to the spinal cord, a series in which all the spinal ganglia associated with the right lumbosacral plexus were removed, and another series dealing with decerebrate animals. He summarizes his results by saying that in spite of the great theoretical and practical importance of the problem, and notwithstanding the large amount of work which has been done to elucidate it, the nature of the muscle tonus has not yet been determined nor has the rôle played by the dorsal roots in its maintenance been made clear. Two theories have been advanced in explanation of these; the proprioceptive reflex theory of Sherrington is the one generally accepted, but the theory of the antidromic conduction of tonic impulses in the dorsal roots has much in its favor and must be given careful consideration. There is no doubt that the plasticity which is responsible for the uniform stiffness and which causes the limb to hold a posture passively imposed upon it, is dependent

upon the integrity of the dorsal roots. According to the theory of muscle tonus that one holds, one can explain this spasticity as a steady reflex contraction called forth by afferent impulses from the tonic muscles themselves, or as due to special tonic reflexes traveling antidromically over dorsal roots.

If it be true then that plasticity or muscle tonus is under the control of the dorsal or afferent roots, and if it be true, as Foerster says, that the corpus striatum in health serves as an inhibitory apparatus, we are supplied at once with two physiological principles upon which to formulate a plan of operative attack.

I am well aware of the fact that there may be some cases of spasmodic torticollis that may be of a functional nature. It so happens that I have never seen a case of what I may call the major type that was effectively treated on this basis. In fact one of the patients in my series was treated for a period of six months on this plan. And I must confess we must acknowledge no means or methods by which one might be able to differentiate between a spasmodic torticollis with and one without an organic basis.

My first experience with the surgical treatment of spasmodic torticollis was many years ago, when in a series of cases I performed the operation as first described by Keen <sup>6</sup> in which one exposed and divided the first three cervical nerves at their points of exit from the spinal canal. The operation was a difficult anatomical dissection and the results, though not perfect, were accompanied by a decided improvement.

Foerster <sup>7</sup> in 1918 advocated section of the dorsal roots for the relief of spasticity alone on the assumption of the generally accepted theory that the dorsal roots control muscle tonus. In 1921 Finney advised section of the posterior branches of the motor roots of the first, second and third cervical segments. In 1924 McKenzie <sup>4</sup> recommended section of the posterior roots for spasmodic torticollis although in the case he reported both the anterior and dorsal roots were divided. In 1927 Sicard, Hagenau and Wallich <sup>8</sup> reported a case of painful choreo-athetosis in which the posterior roots from the fourth cervical to the second thoracic were divided. The results were said to be satisfactory in so far as they concerned the relief of the athetosis, but voluntary control of the arm was almost entirely lost. Finally in 1928 Foerster <sup>2</sup> proposed that after resection of a portion of the rim of the foramen magnum the first four cervical roots be divided.

In further defense of the rationale of the posterior root operation for spasmodic torticollis, reference might be made to the value of this procedure in Little's disease.

It has been said that division of a large number of dorsal roots causes a temporary depression of spinal cord function such as that following transection of the cord. This phenomenon has not been observed by the writer, though in a series of experiments in lower animals Brooks <sup>9</sup> observed a parallelism between cord transection and posterior rhizotomy.

Many muscles are concerned in the movements of spasmodic torticollis.

Their function and nerve supply should be fully understood. Foremost, of course, (1) the sternocleidomastoid which rotates the head toward the contralateral side while tilting it toward the homolateral side. As this muscle stands out conspicuously when in spasm and as the posture of the head consequent upon its contraction is characteristic, it is usually not a difficult matter to determine which of the two sternocleidomastoids is at fault. The muscle is supplied not always exclusively by the spinal accessory but sometimes receives additional fibres from the upper cervical nerves.

(2) The upper portion of the trapezius causes on contraction contralateral rotation and homolateral retraction, simultaneously pulling the shoulder upward. The trapezius always has a dual innervation from the cervical nerves and the spinal accessory.

(3) The splenius capitis and the splenius cervicis which with the semispinalis capitis and longissimus capitis cause homolateral tilting and contralateral rotation. These muscles receive their innervation from the four upper cervical nerves although the splenius capitis and cervicis and the longissimus receive additional branches from the lower cervical and even the upper thoracic nerves.

(4) Finally there is the deepest layer of muscles which after all are the most powerful rotators, to wit, the rectus capitis posticus major and minor, and especially the obliquus capitis inferior. These muscles are supplied in the main by the four upper cervical nerves.

I need not describe the movements that one sees in the form of spasmodic torticollis to which we are limiting our discussion. As a rule the movements vary in frequency and violence in different cases or in the same case at different times. You have all observed what seems like a large functional element. Certainly the movements are always more exaggerated when the patient is in public places, is more or less self-conscious and at times of fatigue or excitement.

Before the operation, if operation there be, is undertaken, one should identify the muscles at fault. This may seem to be devoid of difficulty but from experience I know this not to be the case. In fact, I have disagreed with my colleagues as to this question of laterality. It is well known that as a rule the sternocleidomastoid is affected on one side and the posterior group on the other. But this combination does not always prevail as in some cases the anterior and posterior group may be involved on the same side and in one of my cases the posterior group was involved on both sides.

When the movements are violent and the muscles deep-seated it is a matter of speculation often which muscles are in contraction, but I am inclined to believe that bilateral involvement of the posterior groups will be found more often than we have been wont to believe. As one group contracts more violently than the other, the head will assume the position caused by the contraction of the more powerful group.

Within the past six months four cases of spasmodic torticollis have passed

through the Neurosurgical Service of the University Hospital, two of these having come to the hospital primarily as the patients of my colleague, Dr. William G. Spiller. I shall include an abstract of but one of the four:

CASE REPORT—F. M. C., female, age thirty-eight years (File No. 17448), was referred to the Neurosurgical Service of the University Hospital, November 18, 1929, by Dr. J. C. Roe.

Twelve years ago the patient had a thyroideectomy. After this she noticed her head was twisted slightly to the left and that there was twitching of the muscles of the back of the neck. As time passed she found it became constantly more difficult to hold her head in the normal position. Whenever she becomes nervous or excited the movements are exaggerated and the patient is becoming more and more concerned about her appearance.

The patient is single, well nourished, without any evidence of organic disease or neurological disorder other than the muscle spasm.

Upon inspection one observes frequent jerking of the head during which the right sternocleidomastoid muscle and the posterior muscles on the left side are in rigid spasm. The chin is directed upward and to the left and the head is drawn back and inclined toward the left shoulder. *Diagnosis.*—Spasmodic torticollis. *Operation.*—Rhizotomy C. 2 and C. 3, left, and C. 1, C. 2 and C. 3, right. Colonic anaesthesia.

With the patient in the prone position, head flexed, through a vertical incision the occipital bone and the cervical spine were exposed. A circular section of the occipital bone, including the posterior rim of the foramen magnum, together with spinous processes and laminae of the first three cervical vertebrae were removed. Upon incising the dura one observed on inspection an asymmetrical arrangement of the posterior roots. The roots on either side did not leave the cord at the same level. The first posterior root seen on the right side emerged from the cord at a higher level than the first on the left and so on down to the lowest of the field. Three roots were crushed on the right and two on the left. We planned to crush also the intraspinal portion of the spinal accessory nerve, but curiously enough, though a satisfactory exposure was secured by rotation of the cord and by traction on the dentate ligament, the spinal accessory root could not be seen. Accordingly the wound was closed with tier sutures.

*Immediate result.*—When the patient was discharged from the hospital she had been relieved of the muscle spasm.

In another of the series, two months after the operation I spent three hours with the patient and during the entire time, there were no deviations of the head and neck. In the third case, seen several months after the operation, there were no spasmodic contractions but the head was inclined somewhat to one side as though the posterior group of muscles on the affected side and perhaps the ligaments were shortened by the prolonged period of contraction. The fourth case was still in the hospital when this report went to press. The left spinal accessory nerve in this case was divided in the neck after the rhizotomy. When last examined the posterior muscles were entirely relaxed but there were still some contractions, though moderate, which could readily be traced to the right sternocleidomastoid muscle.

It is apparent from the trend of the discussion that my thoughts are directed toward an operation in which only the posterior or afferent roots are sectioned. I am entirely in accord with Foerster when he says that for all severe cases of what he calls "mobile spastic torticollis," in which a focal organic lesion of the neostriatum is at fault, operation, and operation alone, will afford relief. Those who with me have labored with the extravertebral resection of the first three cervical nerves will welcome a substitute. As

Foerster says the operation is an especially "*mühseliges*" experience and at best is not radical in effect. Hence the proposal to substitute an intra- for an extraspinal exposure is welcome.

Whether one divide the anterior or the posterior roots, or both, by the intradural method is a matter of little consequence from the standpoint of operative convenience and facility, but on the basis of physiological evidence one feels justified in recommending the section of only the posterior roots and the question at once arises as to the number of roots to be divided and whether on one or both sides. The first, second and third must be rendered functionless. One hesitates because of its relation to the diaphragm to disturb either the afferent or efferent pathways of the fourth cervical segment. Should we go further and crush or section the fifth, sixth, seventh, or eighth roots? Even though some of the muscles involved, especially the splenius capitis and cervicis and the longissimus, are supplied by the lower cervical and upper thoracic roots one questions the propriety of interrupting the sensory supply to the upper extremity. One must, therefore, be content to restrict one's attack to the first three cervical roots, whether on one or both sides depends upon whether the posterior group is involved on one or both sides. In some cases there is a reasonable doubt and as a matter of fact in the four cases which form the basis of this report I included the roots of both sides in the operative program.

No matter what the plan of procedure with reference to the cervical roots, every operation for the control of spasmodic torticollis must include severance of the spinal accessory nerve. Usually one can readily see the spinal portion of the spinal accessory nerve in the cervical canal and divide it there.

Little need be said as to the operative technic itself. To one accustomed to laminectomies of the upper cervical canal for the exposure of spinal cord tumors, the operative steps are familiar. I have found it especially convenient before attempting the laminectomy first to rongeur away a centimetre of bone from the posterior margin of the foramen magnum. This renders the first lamina much more accessible and facilitates the removal of spinous processes and laminae of both the atlas and axis. For this operation the position of the patient is precisely that employed in the suboccipital craniectomy.

Once the dura is incised the posterior roots are readily seen. Whether one cuts or crushes or ligates the root is a matter of individual preference. Personally I prefer always to crush the root with artery clamp or a ligature of arterial silk, because when one cuts the posterior roots one may cut a tiny artery accompanying it and a few drops of blood may soil the operative field.

After the roots have been crushed one turns one's attention to the spinal portion of the spinal accessory nerve. For its exposure one must rotate the cord by gentle traction on a dentate ligament. In one of my cases I failed to see the structure in question. Under such circumstances one may always at the same or another sitting expose the nerve in the posterior triangle of the neck. To attempt division of the spinal accessory nerve in the posterior

fossa before its exit from the skull would add an unnecessary hazard to the operation and might lead to complications from injury to adjacent nerves.

After all, any operation for the relief of "spasmodic torticollis" must be regarded as an operation of choice and not one of necessity, since the disease itself has no disastrous effects or fatal tendencies. Hence any proposal of relief by operation must of itself be devoid of risk. The operation recommended may be so classified. In none of the four cases of this series were there any complications and convalescence in all was uninterrupted.

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## THE BACTERIOPHAGE IN SURGERY

By FRED. H. ALBEE, M. D. AND MARJORIE B. PATTERSON

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THE antiseptic method of treating infected wounds reached its culmination during and after the late war when the Carrel-Dakin technic was perfected. The wound was irrigated frequently with a solution combining high germicidal power with low toxicity for the tissues. When the wound was complicated by fracture or loss of bony substance due to trauma or infection, the treatment consisted necessarily of two stages; disinfection, and repair of the bone lesion. Attempts to combine the two necessitated splinting; commonly with plaster, with provision for carrying on the frequent irrigations through tubes that coursed over the infected and granulating surfaces of the bony fragments. This was not only an arduous routine, distressing to both surgeon and patient, but was associated with risk of reinfection. Indeed there was no certainty that reinfection was not being induced today by the very technic that would be used to combat it tomorrow. The method had many other objections, such as the irritation of the skin by the seepage and subsequent evaporation and concentration of the irrigating fluid under the case. The fluid also penetrated and softened the case about the window, so that the area left unsupported constantly increased. Not only was displacement of underlying fracture fragments thus favored, but the protruding soft tissues became oedematous and unfavorable to healing as well as favorable to infection. In many cases these objections debarred one from the use of plaster altogether. With all these drawbacks, the Carrel-Dakin was undoubtedly the most successful method of treatment up to that time, and it could not be criticized in the face of the results that were achieved.

With more sober judgment as the rush of war surgery abated, these objections gained more weight and the pendulum suddenly swung the other way when Orr proposed a method which was the absolute antithesis: for antiseptics he substituted a dressing without germicidal power; instead of perpetual interference, he proposed to let the wound alone for weeks. It was for the treatment of osteomyelitis that Orr proposed his revolutionary method, but it has since been applied to other infective lesions of bones and even to lesions where bone is not involved.

Orr<sup>4</sup> emphasizes four steps in the treatment: (1) primary asepsis or antisepsis to reduce the focal infection; (2) adequate drainage; (3) a post-operative dressing that will protect the wound against reinfection; (4) immobilization, so that movement, pain and muscle spasm are entirely relieved; and with all the parts in correct position for recovery.

With the soundness of these principles one must agree. Undoubtedly



anything that promotes healing enhances local resistance to infection not only by promoting the removal of débris but by bringing to the infected zone all the resources of the blood, both cellular and humoral.

*Operative Technic.*—The extent of the lesion having first been determined from the X-ray, a suitable incision is made for its eventual complete exposure. The site of the incision varies with the circumstances. Generally speaking, it is desirable to approach the bone where it is most superficial. If the incision from previous operation has not healed or healed well, or if a sinus persists there or elsewhere, it is better, when possible, to include such infected tissue in the incision so that scar tissue and necrotic tissue may be trimmed away. If there are scattered sinuses the incision may include one or more; the others are curetted. When an incision is meant to include a sinus, a forceps is first inserted into the sinus to determine its direction and to serve as a guide for the incision. If there is a point of special tenderness or an area of fluctuation, the incision is made over it, if possible. The incision is always made in the long axis of the limb, and is never carried through a muscle group, such as the quadriceps. The mesial side of the thigh is avoided for obvious reasons. It is preferable to follow the general line of cleavage between muscle groups, but one never attempts to dissect the muscles or to follow a fascial plane precisely; a sharp, clean and rapid incision carried immediately to the bone is preferable. If there are any sequestra they are removed. The periosteum is not reflected but is incised around the area to be removed. One may use the single motor-saw, but, as a rule, the osteotome is more practicable. Sufficient bone is removed to uncover the entire lesion as exposure reveals its extent. The primary bone incision is carried beyond the line of demarcation of affected bone, and if any necrotic bone still remains that is chiseled off back into healthy tissue. All sequestra are removed and overhanging ledges trimmed until the margins have a shelving contour best described by the term "saucerized." As healing eventually occurs, the contraction of cicatrization draws the soft tissues into close contact with the bone. From this source, the bone derives additional circulation and its healing, growth and reconstruction are thus aided. Pus and necrotic tissue are swabbed out and the wound cleansed with dry gauze.

Orr's technic was formerly followed at this point and the wound swabbed with iodine and 95 per cent. alcohol. Various considerations have weighed against the use of antiseptics: it is impossible to sterilize a wound with germicides applied for so brief a time; such powerful agents as iodine and concentrated alcohol damage the tissues and provide a nidus for proliferation of such infecting organisms as escape the antiseptic; the care in providing a fresh surface of healthy bone is thus rendered largely futile, since the wound is now bounded by an immediate layer of coagulated blood, and damaged, if not dead, cellular structures in bone and muscle; between healthy tissue and infection there thus lies a dead layer, of microscopic thickness no doubt, which both favors the infection and hinders the exudation of serum and the migration of leucocytes, and must be removed before

the infection is submitted to the full force of the defensive reactions of the body. These arguments against the use of germicides in wounds generally are not new, and they have not been generally accepted. A much more cogent argument against the use of antiseptics developed from the investigations reported in this paper. It will be presented with the discussion of these investigations.

When saucerization and cleansing are completed, the wound is packed with vaseline and vaseline gauze soaked in an excess of sterile yellow vaseline. Since this dressing is semi-fluid at body temperature, it can be readily insinuated into the most remote corners. The packing is allowed to overflow the wound so that it covers an inch or more of skin on either side. It is then well covered with padding, after which the limb is incased in plaster and the joints above and below thus immobilized. No window is left. The dressing is left intact for eight to ten weeks, at which time it is entirely changed and reapplied after simple cleansing, unless the wound is entirely healed. The wound is dressed again as before and left for a similar period. This is repeated until healing is complete. Sometimes the plaster is omitted if healing is well advanced.

*Comment.*—The Orr dressing would appear, at first glance, like putting an effective stopper in the wound. However much it may seem to violate the traditions of free drainage, there is no doubt that drainage is adequate. When the plaster is removed at the end of six or eight weeks, the dressings are often saturated and the limb bathed in pus, which is usually extremely fetid. Drainage is at least free enough to release tension and thus to free the affected tissues from the excessive pressure that would not only promote absorption of toxins but prevent the free circulation of blood and lymph to the lesion which is necessary for sterilization of the wound and repair of structures.

The most striking characteristic of the wound is the appearance of the granulations. They have none of the gray unhealthy appearance commonly manifested by granulations; instead, they are of glistening red color; they are not exuberant or œdematous. They impress one as granulations pursuing a normal uninterrupted course under the most favorable circumstances. By comparing the conditions under which such granulations grow with those present when the wound is dressed by other methods, one gains an inkling of the nature of these favorable circumstances. Growth in the body, whether normal growth of tissues or repair or replacement of structures, takes place under the mutual pressure of tissues. The permeation of tissues by blood and lymph is normally regulated in accordance with this pressure. It is reasonable to assume that, when a tissue is relieved of the counterpressure of neighboring tissues, this balance, both circulatory and osmotic, is upset. The severed tissue must tend to become hyperæmic and œdematous. The overnutrition and sluggish drainage result in exuberant, unhealthy granulation tissue. When the wound is well packed with vaseline gauze and enclosed in a dressing surrounded by plaster, so that pressure is uniform over the

wound and the surrounding structures, the normal appearance of the resulting granulations suggests that normal physiological pressure has been restored by the dressing. Indeed, the pus is expressed and the packing extruded from the wound by the pressure of the growing tissues. The point at which this equilibrium is maintained by this dressing is apparently that which is optimal for healing tissues. The speed of epithelialization and the rapid assumption of a normal appearance by the new skin suggests that the healing of all structures is greatly favored by the equalization of pressure at an optimal level. This principle may be applied to the treatment of varicose ulcers since it is presumably this mechanism which explains the rapid and satisfactory healing of these lesions when the vaseline and plaster dressing is used.

The influence of infection and inflammation on the health of granulations must not be overlooked. The normal circulatory response to injury is hyperæmia and œdema which undoubtedly contribute to the unhealthy overgrowth of granulations. There must be, then, some other factor besides counterpressure to account for the condition of the granulations. It has been suggested by one of us (F. H. A.<sup>1</sup>) that some principle is retained in the wound, by this method of dressing, which will, if undisturbed, contribute materially to the destruction of the infecting organisms. It is probable that this consists in part of the antibodies and living phagocytes; but the further suggestion was made that the specific bacteriophage accumulated in the wound if it was not dissipated too rapidly by drainage, irrigation and frequent dressing. There are thus two causes which may be suggested for the phenomenal results produced by this new method of dressing: one is mechanical and physiological, the other is concerned with those newer principles in bacteriology which have to do with the nature and action of the bacteriophage.

The work which we have conducted since the original suggestion was undertaken to discover whether a bacteriophage can be demonstrated in the wound after it has been enclosed in an Orr dressing for some weeks, whether such bacteriophage is specific for any of the infecting organisms, and whether and to what extent the character of that organism is changed in the presence of the bacteriophage.

Upwards of 100 cases have been treated by the closed method since it was begun nearly three years ago. The bacteriological investigation has covered about a year.

*Bacteriological Procedure.*—Pus obtained from the wound at operation or at subsequent change of plaster dressing was sent to the laboratory for cultural examination. The viable bacterial flora were determined and a record made of the relative numerical predominance of the organisms present. The strains occurring in largest numbers were thought to be of some etiological significance, or secondary invaders with which in chronic osteomyelitis the host must cope for long periods of time and were, therefore, worthy of study. In a search for the presence of a lytic agent which might

account for the clean appearance of wounds treated by the Orr method, it was first necessary to determine the susceptibility or resistance of these strains of bacteria to lytic action. This was done by subjecting them to the action of suitable stock races of bacteriophage of high titre. The fermentative reactions of organisms under study were determined at each examination as one means of identifying the same strain or of ascertaining biochemical changes which might be brought about by environmental conditions in the wound. Broth cultures of the wound pus after twenty-four hours' incubation were filtered through Berkefeld N filters and these bacteria-free filtrates tested for the presence of native bacteriophage. Since d'Herelle<sup>2</sup> has shown that strong lytic principles isolated from the human intestine in health and disease may show action against few or many of the bacteria constituting the flora, known susceptible strains of the species corresponding to those present in the wounds were employed in addition to the wound strains in an effort to demonstrate readily the presence of lytic agents in these filtrates.

CASE I.—The patient, aged ten years, was admitted to the orthopædic service with a diagnosis of chronic multiple osteomyelitis. The infection was apparently hæmatogenous. Two operations had been performed within the previous year at another hospital. After admission to this service sequestrectomy of both tibiæ was done and an abscess of the right heel was incised and drained. Eight weeks later when the condition of the patient warranted further surgical intervention, sequestrectomy was done upon the left humerus which had shown draining sinuses for nearly a year. In each instance the Orr technic was employed in treatment. The three wounds were studied and the bacterial flora compared at every subsequent change of dressing.

*Right Tibia.*—Cultures from the wound at operation showed hæmolytic *Staphylococcus aureus* to be the predominating organism, with *B. coli* (*acidi lactici*) present in fewer numbers. This staphylococcus was not a lysogenic strain, but was susceptible to lysis by four stock races of anti-staphylococcus bacteriophage, while the strain of *B. coli* was lysed by two of the thirteen races of anti-*coli* bacteriophage to which it was subjected. The filtrate of a broth culture of the pus from the wound showed the presence of a native bacteriophage which when first isolated was active against two stock strains of *B. coli* known to be susceptible to lysis. After having been exalted with one of these by the usual method of serial passages, feeding and filtering for six generations, a titre of 1 times  $10^{-9}$  was reached. It was interesting then to determine whether this bacteriophage present in the filtered culture from the wound was also capable of bringing about lysis of the strain of *B. coli* associated with it in the lesion. After five serial passages with this bacillus complete lysis was obtained with a titre of 1 times  $10^{-8}$ . It was impossible to demonstrate a lytic principle in the filtrate which showed any action upon either the hæmolytic *Staphylococcus aureus* present in the wound or against three stock strains of *Staphylococcus aureus* known to be susceptible to lysis.

After an interval of seven weeks, when the dressing was changed, the size of the wound, which at operation measured 11.5 centimetres long by 4 centimetres wide, was now reduced to 7.5 times 2.5 centimetres. A moderately fetid odor was observed; the skin about the wound showed no irritation and healthy granulations of a red color evidenced satisfactory healing. At this time *B. coli* (*acidi lactici*) was found to be the predominating organism. Hæmolytic *Staphylococcus aureus* present at operation was not recovered. *B. pyocyaneus* was present in small numbers. From the filtrate of the broth culture obtained at this time an anti-colic bacteriophage was again isolated which was active against the same stock strain of susceptible *B. coli* as was employed in the

first examination. Enhanced with this strain to a titre of 1 times  $10^{-8}$ , the principle after six serial passages now showed no activity against the wound strain of *B. coli* recovered at this time, although this organism was lysed to the same degree by the same stock races of anti-*coli* bacteriophage as were employed at the first examination to determine the susceptibility of the strain to lysis. Four weeks later at the third examination and second change of plaster dressing the wound measured 6.5 times 2 centimetres and showed firm granulation tissue. Diphtheroids were now the predominating organism, while *B. coli* (*acidi lactici*) had dropped to second place; *B. pyocyaneus* was still present in small numbers. The strain of *B. coli* again gave the same fer-

TABLE I  
CASE I.—*Chronic Multiple Osteomyelitis*

<i>Right Tibia</i>	<i>Left Tibia</i>	<i>Left Humerus</i>
First specimen Sept. 9 Hæmol. Staph. aureus* <i>B. coli</i> and Active Native anti- <i>coli</i> phage	Culture not obtained	
Second specimen Nov. 11 <i>B. coli</i> <i>B. pyocyaneus</i> Native anti- <i>coli</i> phage	First specimen Nov. 11 Non-hæmol. Staph. aureus Hæmol. Staph. aureus <i>B. coli</i> , <i>B. pyocyaneus</i> Native anti- <i>coli</i> phage	First specimen Nov. 7 Hæmol. Staph. aureus Phage not detected
Third specimen Dec. 9 Diphtheroids <i>B. coli</i> <i>B. pyocyaneus</i> Phage not detected	Second specimen Dec. 9 <i>B. pyocyaneus</i> Diphtheroids Phage not detected	Second specimen Dec. 9 Diphtheroids Hæmol. Staph. aureus Stock anti-staphylococcus Phage introduced
Fourth specimen Dec. 23 <i>B. coli</i> <i>B. pyocyaneus</i> Hæmol. Staph. aureus Phage not detected Wound $\frac{1}{4}$ area of Sept. 9	Dec. 23 Wound healed	Third specimen Dec. 23 Diphtheroids Hæmol. Staph. aureus Anti-staph. phage recovered from scrapings Wound healed

\* Organisms are listed in the order of their predominance in the wound.

mentative reactions and was susceptible to lysis by the same stock races of anti-*coli* bacteriophage against which it had been previously tested. No native bacteriophage could be recovered at this time. One is mindful, however, that inability to demonstrate the lytic principle *in vitro* does not exclude its presence *in vivo*.

After another interval of two weeks, at the fourth examination and the third change of dressing the wound had decreased in size to 5 times 1.5 centimetres and showed beginning epithelization. Cultures showed *B. coli* (*acidi lactici*) predominating, *B. pyocyaneus* also present and the appearance (which may have been the reappearance) of a few colonies of hæmolytic. *Staphylococcus aureus*. Both the *B. coli* and the *staphylococcus* were susceptible to the stock races of bacteriophage active against them in the beginning. No native bacteriophage could be demonstrated at this examination. At the fourth dressing the wound had granulated in to approximately one-quarter the size of the original incision and showed marked new epithelialization.

It is interesting to note that from the first cultural examination of this wound a bacteriophage was isolated which was active against a stock-susceptible strain of *B. coli* and by the use of this the titre of this lytic principle was increased. The bacteriophage thus exalted was able to cause complete lysis of the wound strain of *B. coli*. At the second examination a bacteriophage was again isolated which was active against the same stock-susceptible strain of *B. coli* and was regenerated by it. However, this regenerated principle now showed no action upon the wound strain of *B. coli*. The third and fourth examinations revealed no bacteriophage at all. One may infer that in the interval of seven weeks the organism had undergone some change which at this time enabled it to resist *in vitro* the action of the native bacteriophage still present in the wound, although it was capable of being completely lysed by the stock races of bacteriophage to which it was susceptible in the beginning. It cannot be said, therefore, that the strain was resistant in a general sense, but rather that it had acquired some specific resistance to the native bacteriophage.

*Left Tibia.*—Although the right and left tibiae were operated upon at the same time, the specimen from the left tibia was lost and unfortunately cultural examination was therefore deferred until the first change of plaster dressing seven weeks later. Here again the size of the incision was reduced from 8 times 2.5 centimetres at operation to 2.5 times 0.75 centimetres at this time. Healthy granulations were filling the wound and extensive epithelization was taking place. No œdema or skin irritation was noted. The following organisms constituted the wound flora at that time and are given in the order of their numerical predominance: non-hæmolytic *Staphylococcus aureus*, hæmolytic *Staphylococcus aureus*, *B. coli* (acidi lactici), *B. pyocyaneus*. The broth filtrate contained a bacteriophage active against a stock-sensitive strain of *B. coli* which, when exalted to a titre of 1 times  $10^{-7}$ , was not, however, lytic for the *B. coli* from this wound. No lytic principle could be recovered which showed any action against the strains of *Staphylococcus* in the wound; neither did the native anti-*coli* bacteriophage have any action upon them, although they in themselves were susceptible to lysis by stock anti-staphylococcus bacteriophages.

One month later, at change of plaster dressing, the wound was completely covered with new epithelium and healed. While surface scrapings only were available for culture, it is worthy of note that both the staphylococcus and *B. coli* had disappeared and only *B. pyocyaneus* and diphtheroids remained, possible surface residents.

*Humerus.*—Seven weeks after the operations upon both tibiae sequestrectomy of the left humerus was performed. The wound measured 9 times 4 centimetres. Cultures showed only few colonies of hæmolytic *Staphylococcus aureus* which were proven to be susceptible to lysis. No native bacteriophage could be recovered from this wound at this time or at any subsequent examination. At first change of dressing the picture presented here was in marked contrast to those of the right and left tibiae. The skin was markedly irritated, being reddened and excoriated. Granulations were of a grayish-pink color and somewhat œdematous. Although there was a moderate amount of thin pus present, there was only slight wound odor. Since no native bacteriophage could be demonstrated, it was determined to employ as a therapeutic agent at this time a stock bacteriophage to which this wound organism had been proven susceptible when first isolated. That such an organism might during an interval of one month have become resistant, was a possibility. However, the staphylococcus isolated from a culture taken before the bacteriophage was introduced into the wound was still capable of being completely lysed by the bacteriophage used in the treatment. Two weeks later the wound was covered with new epithelium and the skin appeared normal. A swab culture of the surface area revealed a few colonies of hæmolytic *Staphylococcus aureus* and many diphtheroids. A filtrate of this culture showed an anti-staphylococcus bacteriophage which we assumed was the principle introduced at the previous dressing.

This case would seem to suggest that at the time of operation the recovered lytic principle is active against the organism of the corresponding species present in the wound, but that at subsequent examinations the organism, which we assume to be the same strain reappearing, has acquired some form of resistance to the bacteriophage with which it has been associated. That it lingers in the wound up to the time of complete healing with unaltered pathogenicity has not been proven by experiments to determine comparatively its pathogenicity at different stages of healing; but in the light of such a wholly satisfactory clinical result it may be inferred that either the pathogenicity of the organism for this host has been lost or that tissues have acquired greater resistance to such bacterial virulence than they had originally.

CASE II.—The patient was a woman aged twenty-one years. Two months previously she had been hurt in an automobile accident which resulted in a compound comminuted fracture of the left radius and ulna. On admission to this hospital bone fragments were projecting through the wound, and there was sloughing of the tissues on the volar and dorsal aspects of the forearm with osteomyelitis of the radius and ulna. Sequestrectomy was done, with application of the Orr technic. The wounds contained much pus; the dorsal incision was 10 times 5 centimetres while that on the volar aspect was somewhat larger, measuring 14 times 5 centimetres.

Cultures from pus removed at operation showed *B. coli* (acidi lactici) predominating and a few *Staphylococcus aureus*, both organisms being susceptible to lysis. A filtrate of the broth culture yielded an anti-staphylococcus bacteriophage which had a lytic exponent of -8 when exalted with a stock-susceptible strain of *Staphylococcus aureus* and was then able completely to lyse the *Staphylococcus aureus* of the wound. On the other hand the original broth filtrate was negative for lytic principle when carried by serial passage for six generations with the *Staphylococcus aureus* and *B. coli* of the wound.

After seven weeks, at the second examination and first change of plaster dressing both incisions had become smaller, the dorsal wound measuring 6.5 times 2.5 centimetres and showing some new epithelium, the volar aspect approximating 11 times 4 centimetres. In each instance the granulations were healthy and red and there was no skin irritation and very little fetid odor. Clinically, the picture was that of a healthy granulating wound. The same organisms were encountered, *Staphylococcus aureus* this time predominating. No bacteriophage could be recovered, although the strain of staphylococcus from the wound was still susceptible to lysis by the regenerated native anti-staphylococcus bacteriophage isolated at the first examination.

After another interval of seven weeks *Staphylococcus aureus* was the only organism present; the strain of *B. coli* having disappeared. Here again no lytic principle could be isolated.

The wound on the dorsal aspect of the forearm was healed and, since the volar aspect measured only 7.5 times 2.5 centimetres and showed a marked amount of new epithelium, the plaster dressing was discarded and replaced by the vaseline gauze dressing.

Four weeks later healing was complete.

CASE III.—The patient, aged forty years, was admitted to the hospital with a diagnosis of osteomyelitis of the left tibia of thirty-six years' duration. Two previous operations were unsuccessful and had left a draining sinus. Saucerization was done and an Orr dressing applied.

Cultural examination of pus from the wound showed hæmolytic *Staphylococcus aureus* predominating with a few diphtheroids present. From the broth filtrate an anti-staphylococcus bacteriophage was isolated which was active against a stock-susceptible strain of staphylococcus with a lytic exponent of -9. Here again the exalted

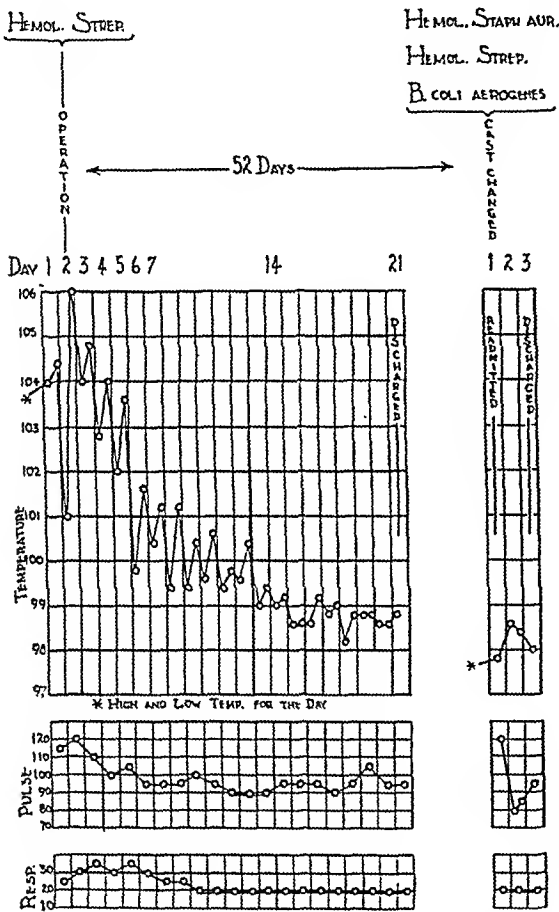
## THE BACTERIOPHAGE IN SURGERY

principle was lytic for the wound staphylococcus, though the broth filtrate showed no lytic agent capable of acting upon it directly without having been regenerated.

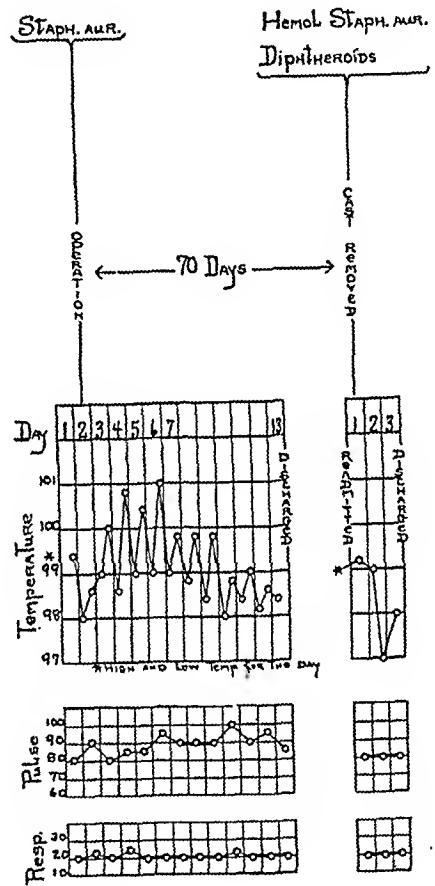
Later, at the first and second changes of plaster dressing, diphtheroids predominated, only a few colonies of hæmolytic *Staphylococcus aureus* being present. It was not possible again to recover a lytic principle from this case.

At the third examination, when the wound was granulating in satisfactorily and marked epithelization was taking place, a vaseline gauze dressing was substituted for the plaster.

CASE IV (Graph 1).—The patient, aged twenty-one years, was admitted to the orthopædic service with a history of fracture of the right ankle seven months previously for which four operations had been performed elsewhere. He was progressing well



GRAPH 1.—(Case IV.) A case of infection with *Streptococcus hæmolyticus* showing lysis of the high temperature.



GRAPH 2.—(Case V.)—A case of infection with *Staphylococcus aureus* showing how the reaction in temperature (and in general condition) may not be immediately favorable.

until a week prior to admittance when the ankle became swollen and tender. A diagnosis of acute osteomyelitis of astragalus and scaphoid of the right foot was made. Incision and drainage with Orr treatment was performed. At this time the temperature rose to 106 degrees F. A blood transfusion of 500 cubic centimetres was given the same day and, with only the usual post-operative care, the temperature receded gradually. Cultures made from material removed at operation showed the presence of a single infecting organism, *Streptococcus hæmolyticus*. During the period of fifty-two days following operation no complications developed. At the first change of cast the wound was granulating satisfactorily and the organisms present in the order of their predominance were hæmolytic *Staphylococcus aureus*, *Streptococcus hæmolyticus* and *B. coli aerogenes*. Four weeks after the operation, when the dressing was removed the second time, the wound was found completely healed.



In this instance, as well as in four other cases of chronic osteomyelitis treated by the same method in which *Streptococcus hæmolyticus* was the single infecting organism or predominating in a mixed flora, there was evidence of the existence of streptococcus bacteriophage of a low order apparently similar to that described by Dutton.<sup>3</sup> Filtrates of wound pus showed action upon a stock-susceptible strain of *Streptococcus hæmolyticus* but clearing lasted only for from three to six hours at 37° C. and was then followed by secondary growth. Due to the tendency of streptococcus to dissociate rapidly in fluid medium at the optimal  $P_H$  for phage action, difficulties were encountered in an effort to raise the titre of these principles. An attempt to "train" bacterial strains to regenerate these principles was made by employing the technic described by Schwartzman.<sup>5</sup> In each instance after fifteen passages of the organisms through the phages the apparent increase in titre was slight. The significance of such weak lytic principles in the healing of streptococcus-infected wounds requires further detailed bacteriological study, but their occurrence in lesions of this type is recorded with due regard for the fact that conditions in the wound may provide necessary factors for the completion of processes which are by present technic only partially demonstrable *in vitro*.

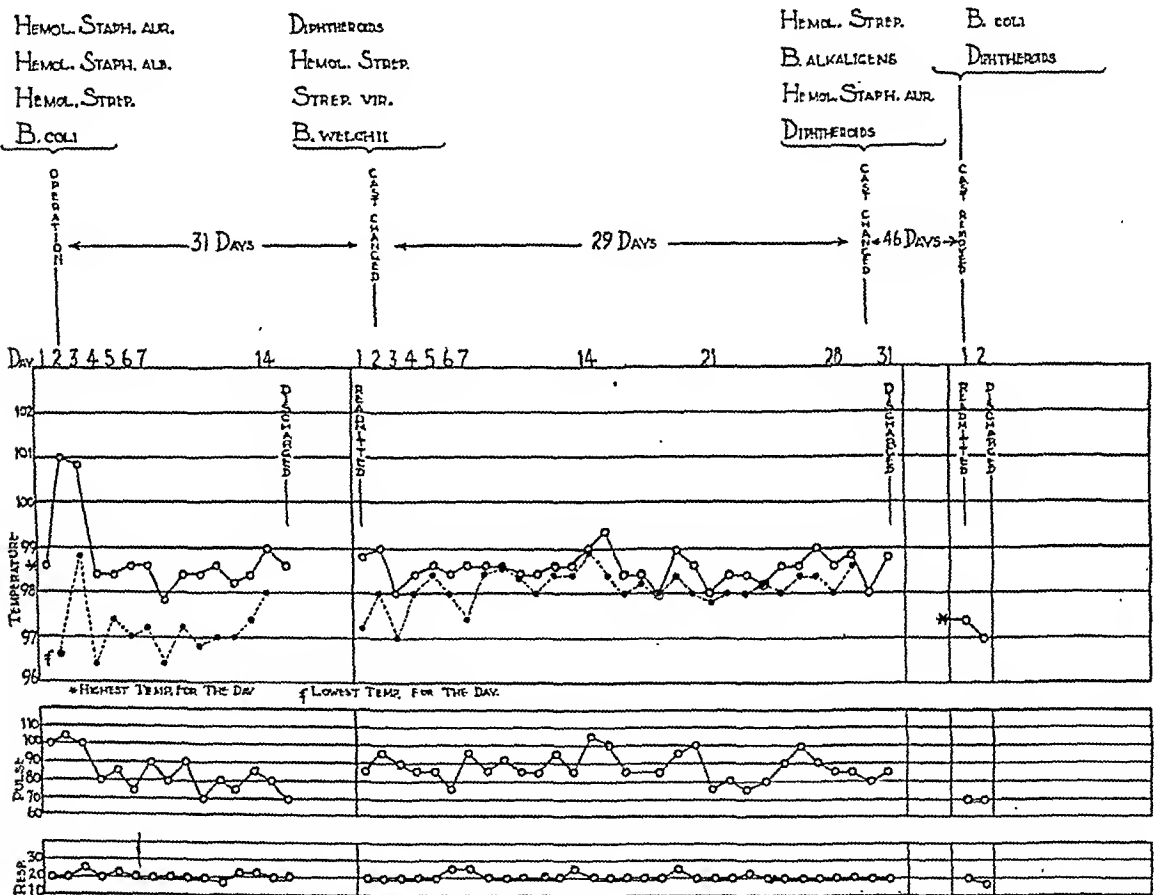
The presence of hæmolytic streptococcus infection and a high temperature in this case might be considered a weighty argument against what seems like sealing up the infection. The effect of the operation is indicated in the graph; the general condition paralleled the temperature curve. It may eventuate that a high temperature with streptococcic infection will be considered an added indication for this type of operation.

CASE V. (Graph 2).—The patient, aged thirty-eight years, gave a history of fracture of humerus two years previously. Bone graft was attempted at another hospital but was followed by non-union, and infection occurred leaving a draining sinus which had been treated by the Carrel-Dakin method. Upon admittance to this hospital a diagnosis of osteomyelitis of left humerus following an onlay bone graft was made. Sequestrectomy was done and an Orr dressing applied. This wound also showed only one infecting organism, *Staphylococcus aureus*. Although the temperature did not at any time exceed 101° F., it was not until after the sixth day that it began to subside. The not uncommon observation in this treatment, that the temperature may not subside for several days following the operation, has been previously reported by one of us (F. H. A.<sup>1</sup>). The plaster dressing was removed after seventy days. At this time the cultures showed a hæmolytic strain of *Staphylococcus aureus* and diphtheroids, and the wound was granulating in satisfactorily. At the second subsequent change of dressing four months later, the wound was found healed. Two months later an inlay was inserted. There was no recrudescence of infection and union of the graft was solid after two months had elapsed. This affords striking proof of the satisfactory and permanent disappearance of the infection under this method of treatment.

CASE VI (Graph 3).—The patient, aged twenty-years, was admitted to the hospital with a previous history of injury to the left thigh, several operations having been performed elsewhere, which resulted in a draining sinus in the left leg of two years' duration. A diagnosis of chronic osteomyelitis of the lower two-thirds of the femur was made and sequestrectomy performed, followed by Orr treatment. Hæmolytic *Staphylococcus aureus* and albus, *Streptococcus hæmolyticus* and *B. coli* constituted the mixed

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flora at operation. Thirty-one days later at change of the plaster dressing three swabs obtained from different areas of the wound were sent to the laboratory. Cultures from each of these showed diphtheroids, *Streptococcus hæmolyticus*, *Streptococcus viridans* and *B. welchii*. One hundred cubic centimetres of mixed welchii and tetanus antitoxin were administered upon receipt of the cultural findings and the cast was allowed to remain as usual. No change was noted in temperature, pulse or respiration and the patient made no special complaint. After twenty-nine days, at second change of plaster dressing, cultures were negative for *B. welchii*; the changes in the flora may be seen by the graph. Following an interval of forty-six days the plaster dressing was removed and a gauze dressing applied since the wound was almost covered with epithelium, and so nearly healed that the patient was told he need not return unless there was further trouble. This was three and a half months after the operation.



GRAPH 3.—(Case VI.) Mixed infection (including *B. welchii*), indicating the slight systemic response to the presence of an organism generally considered highly virulent, and in this case fatal to a guinea pig.

Three other such cases of mixed infection in which *B. welchii* was recovered from the wound either at operation or at subsequent change of dressing have been studied. In each instance there was a history of compound fracture resulting from an accident, or of chronic wounds previously subjected to one or more operations. In Case VI a possible explanation is the occurrence in the tissues of spores of an attenuated strain of *B. welchii*, lying dormant since the time of the accident or previous incision. Unfortunately no test was made to determine the pathogenicity of this strain. To save confusion, no reference to the presence of *B. welchii* was made in the presentation of Case II. It was found not only at the time of operation but at the first subsequent change of dressing. One cubic centimetre of the

twenty-four-hour mixed broth culture obtained at the time of operation was injected intramuscularly into a 400-gram guinea pig, causing death in twenty-two hours with marked hæmorrhagic gelatinous œdema, characteristic of toxic strains of *B. welchii*. Mixed antitoxin was administered to the patient, but here again the plaster dressing was allowed to remain and no untoward symptoms ensued. Cultures obtained at the first change of dressing showed *B. welchii*, which in a mixed broth culture again caused the death of a guinea pig in the same number of hours; thus no loss in virulence was indicated. It is evident that although this strain of *B. welchii* might be considered pathogenic by animal test, the host was able to tolerate or overcome it, since it was not recovered from the wound subsequently and no untoward symptoms were manifested. That spore-bearing anaërobes probably occur in many types of wounds more frequently than we realize may be due to the fact that no search is made for them, or that, as in these instances, through some protective mechanism the host is able under certain conditions to tolerate them, and no clinical evidence of their presence appears.

It will be recalled that the wound in Case II contained also an anti-staphylococcus phage and, since filtrates from Case VI as well as the other cases in which *B. welchii* was present showed anti-streptococcus bacteriophage of low order, there is the suggestion that these lytic principles may be one of the many contributing factors in the complex environment of the wound which would seem to establish an amicable relationship between the host and this parasite, which under other circumstances may be regarded with alarm. In Cases II and VI antitoxin was administered, but, since there was no clinical evidence of the activity of *B. welchii*, it was decided to withhold this measure in the other two cases, which, however, went on to complete healing without untoward symptoms. We are far from suggesting that *B. welchii* is not to be taken seriously. Its presence, in traumatic cases at least, must continue to call for immediate measures. The difference in its behavior in these chronic cases is noted largely because of the scientific interest.

Two cases similar clinically, one having a single infecting organism, *Staphylococcus aureus*, and the other an initial mixed flora of *Streptococcus hæmolyticus* and *Staphylococcus aureus*, were studied carefully by the same technic for the presence of bacteriophage. No lytic principle was recovered, however, either at the time of operation or upon subsequent cultural examination.

In ten cases in which no search was made for lytic principle, data are available for study of the wound flora and the relative predominance of the organisms at varying intervals through the period of treatment.

It must be borne in mind that material sent to the laboratory for study may not be taken in each instance from the same area of the wound, and data may thus be seemingly contradictory. As the gradual loss in virulence of the infecting organism for the host proceeds, secondary invaders may appear in larger numbers proportionately. Again secondary invaders derived

from the skin may be washed into the wound by the sweat. In spite of the general prevalence of diphtheroids and the frequency with which they occur as contaminants in the laboratory, our findings seem consistent in the fact that these organisms are seldom recovered from osteomyelitis wounds at operation unless the lesion be one of long duration. They were, however, present in large numbers toward the end of the period of observation and in some instances gained predominance in the flora. Their possible favorable prognostic significance is not discussed.

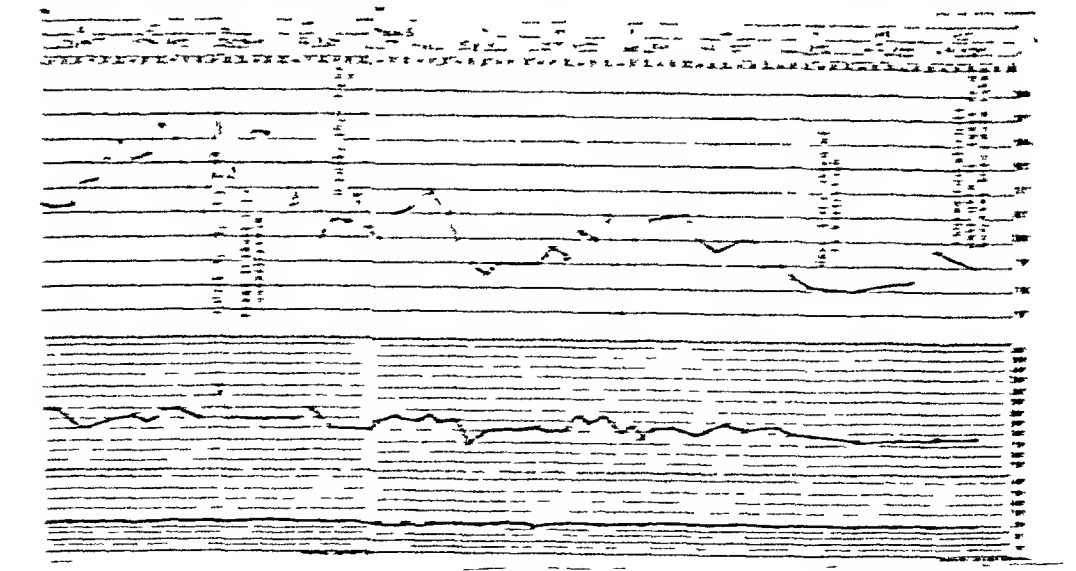
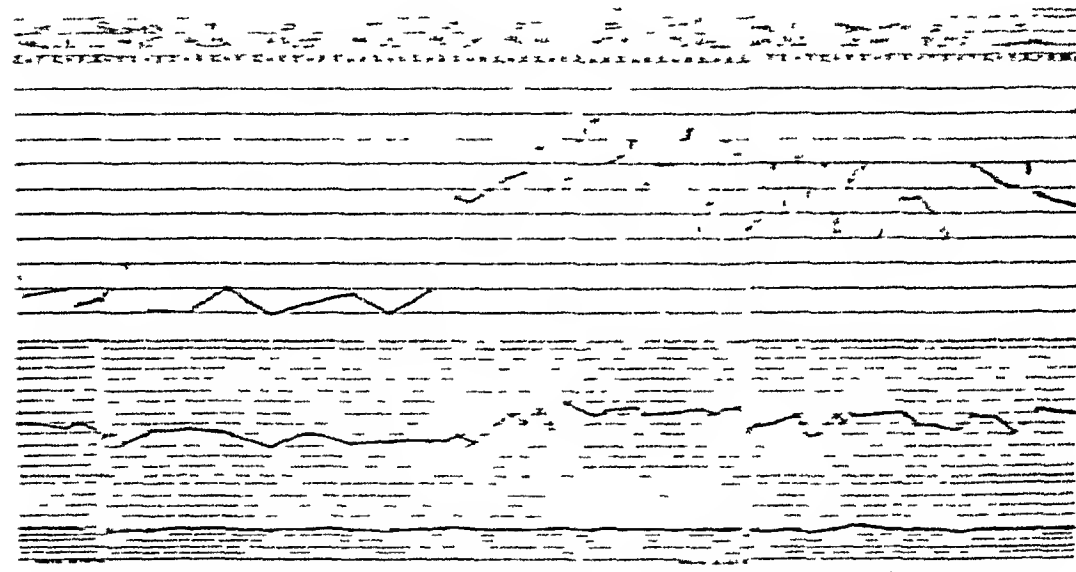
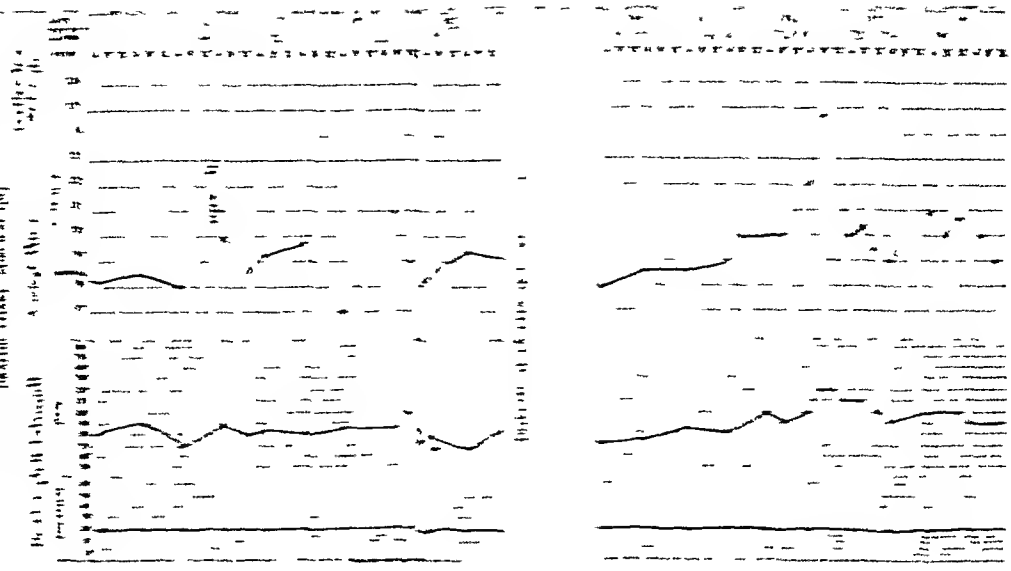
CASE VII (Graph 4).—In this case the patient, a man aged thirty-five years, had suffered a compound comminuted fracture of the left tibia and fibula as the result of being caught in the gears of a massive machine, September 19, 1929.

He was first seen by one of us (F. H. A.) four months later. The leg was found encased in a fenestrated plaster-of-Paris case, which had been applied six weeks before. There was a discharging wound with abundant unhealthy granulations six inches above the ankle on the anterior aspect. The leg was markedly distorted and palpation revealed malposition and non-union of the fragments. The X-ray (Fig. 1) confirmed the evidence of displacement and non-union and revealed an extensive mass of callus reaching from the superior toward the inferior fragment of the tibia. Several sequestra were also shown.

At operation the following day, January 16, 1930, the limb in the region of the osteomyelitis and pseudarthrosis was widely opened by an incision extending above and below the discharging wound. Several sequestra of considerable size were lifted out, and much thick pus and detritus removed with curette and dry gauze. Culture of the pus revealed *Staphylococcus aureus* (predominating), *B. pyocyaneus* and a few *Staphylococcus albus*. The bone surfaces were freed so as to be brought into alignment after the removal (with some difficulty) of the mass of callus. Then, with the Albee motor saw, the ends of the tibial bone fragments were shaped into the male and female parts of a mortise joint. The placement of the mortise, together with the straightening, brought about sufficient tension to hold the fragments in place, without the necessity for any internal fixative such as kangaroo tendon. As already stated, no germicide was used. When the fragments were restored, excellent alignment was attained (Fig. 2) but there was a great deal of dead space, especially on the posterior aspect where the mass of callus had been removed. This was packed with yellow vaseline supplemented with vaseline gauze placed more anteriorly in the wound. The value of this semi-fluid dressing has already been described; it was particularly advantageous in a case of this kind. The dressing was finished by the method already described, the plaster extending from mid-thigh to the bases of the toes.

For the next day or two there was moderate fever, but this soon abated. Convalescence was uneventful for about a month when the patient was seized with severe pain in the right flank. The temperature rose to a maximum of 104.4°. It quickly abated, but ten days later it rose again to the same level; pus was found in the urine, and Dr. Joseph J. McCarthy, called in consultation, diagnosed acute pyelitis of both kidneys. The urine was found negative for tubercle bacilli, but *B. coli* (*acidi lactici*) was present in large numbers (700,000 per cubic centimetres). The erythrocyte count was 2,750,000 per cubic millimetres and the leucocyte 12,800 per cubic millimetres. The urine was loaded with both types of blood-cells. The bacteriophage principle was again invoked. Under the direction of Doctor McCarthy, a specific bacteriophage was prepared and introduced by urethral catheter into each pelvis. At this time there were 3,000,000 colon bacilli per cubic centimetres of urine. The patient's reaction was very prompt. The temperature fell, his pain abated and he felt quite comfortable and regained his appetite. The day after this treatment there were only 16,000 bacilli per cubic centi-

TIME FROM FIRST GRAVITY RECORD AT 441000 UNTIL 110000 H



These data were collected from a single source and are presented in this format for comparison. The data show a clear trend of increasing values over time, with some fluctuations. The overall pattern suggests a steady increase in the measured quantities, with the rate of increase appearing to be relatively constant.

metres. The severity of the fever during the time required for the preparation of the bacteriophage is indicated in Graph 4, as is the fall of three degrees or more during the two following days. After the second similar treatment a week later, the temperature stayed practically normal. The condition on the day of the first treatment was serious as the temperature of 105° and pulse of 120 indicates.

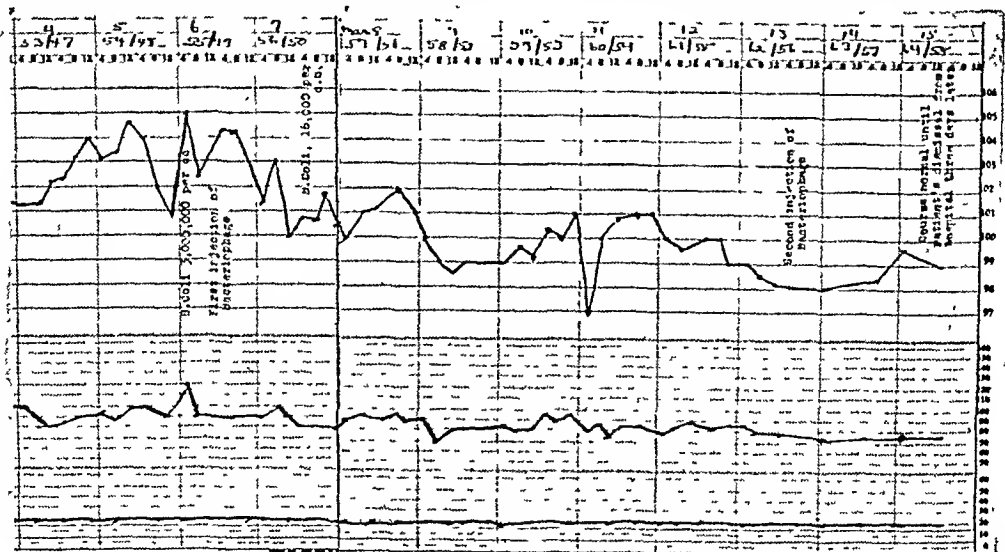
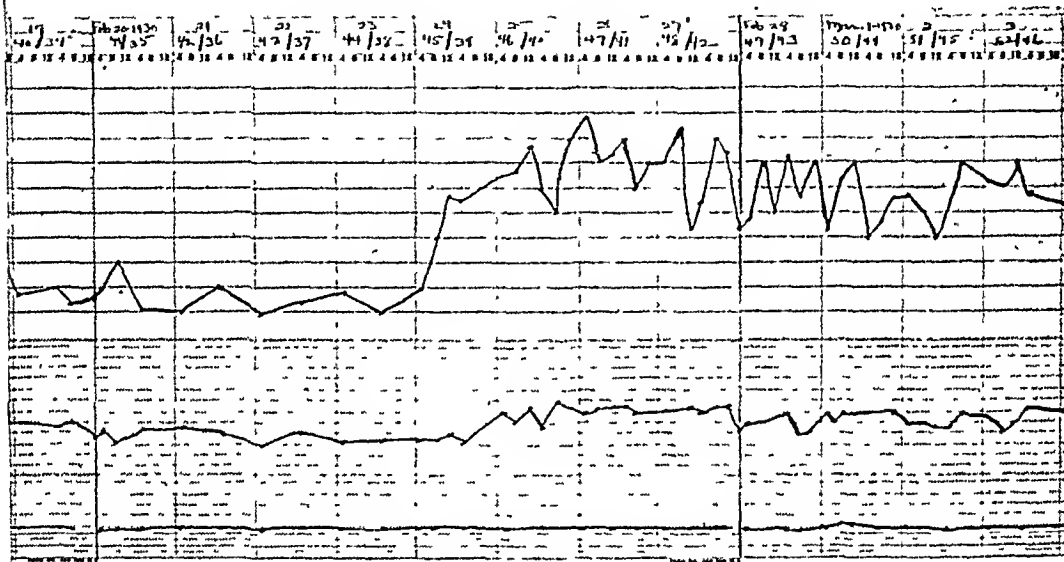
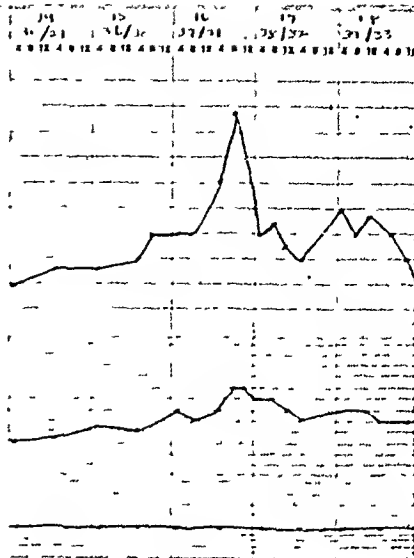
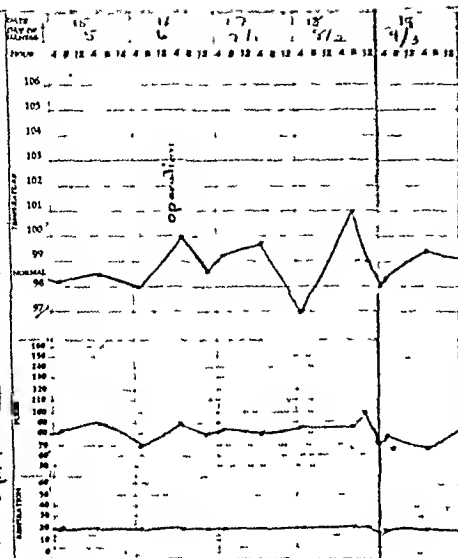
Through this difficulty there was no indication that the leg was responsible and the dressing was not touched until the usual time had elapsed. Then it was found that the vaseline gauze had been entirely extruded, the wound was healed except for an area the size of one's thumb-nail, and bony union was almost complete.

*Discussion.*—Three cases have been reported in which it has been possible to recover races of anti-coli and anti-staphylococcus bacteriophage from wounds of osteomyelitis treated by the modified method of Orr. These lytic principles when isolated have shown specific action against bacterial strains present in the wound. Since it has been impossible to prove *in vitro* that the native lytic agent was active against more than one of the bacterial species constituting the wound flora, it would seem that the original pathogenicity of this organism, possibly altered by environmental factors, might have been a determining factor in the cause of the disease.

It is not our purpose at this time to enter into the controversy concerning the origin and proliferation of the bacteriophage but if we can assume for the moment that the principle multiplies with destruction of the sensitive bacterial cells the sequence of events in Case I becomes clear. It will be remembered that while the wound was healing rapidly and favorably the *B. coli* manifested first its sensitivity and later resistance to the native bacteriophage which thus first failed to lyse the *B. coli* and finally disappeared before healing was complete. It seems fair to conclude that the *B. coli* while acquiring resistance to the bacteriophage lost virulence for the host and that the bacteriophage having no pabulum in the way of susceptible bacteria disappeared. Healing went on favorably because the service of the bacteriophage had been accomplished.

The explanation of Cases II and III is not so simple. In both these cases the bacteriophage isolated at the first examination disappeared, but the organism in the case, a staphylococcus, not only persisted but remained sensitive to the native bacteriophage previously isolated. If this is not attributable to a laboratory error the explanation can be afforded only by further investigation which may entail extensive serological studies as well as further studies in the morphology and antigenic properties of the organism isolated at various stages in the healing of the wound.

In bacterial studies one is ever mindful of the danger of comparing the result of reactions observed *in vitro* with those which may occur *in vivo*. It is not our conception that lytic action so vividly demonstrated in the test-tube proceeds at as rapid a rate in the wound where other environmental factors are to be considered, but that if this lytic principle is undisturbed in the wound a process, perhaps less rapid *in vivo*, may through its specificity eliminate or alter the virulence of invading organisms and thus facilitate healing processes and shorten the course of treatment in osteomyelitis. Since



GRAPH 4.—(Case VII.) Temperature and pulse chart in a case complicated by pyelitis. The severe reaction is indicated particularly in the temperature curve, but the patient's response to the injection of bacteriophage was even more spectacular than that indicated by the temperature and pulse readings. The portion of the chart covering the uneventful period has been removed.

## THE BACTERIOPHAGE IN SURGERY

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FIG. 1.—Ununited fracture of tibia and fibula in Case VII. Marked malposition and over-riding and non-union of the fragments are evident, as well as the extensive mass of aimless callus and the multiple sequestra.

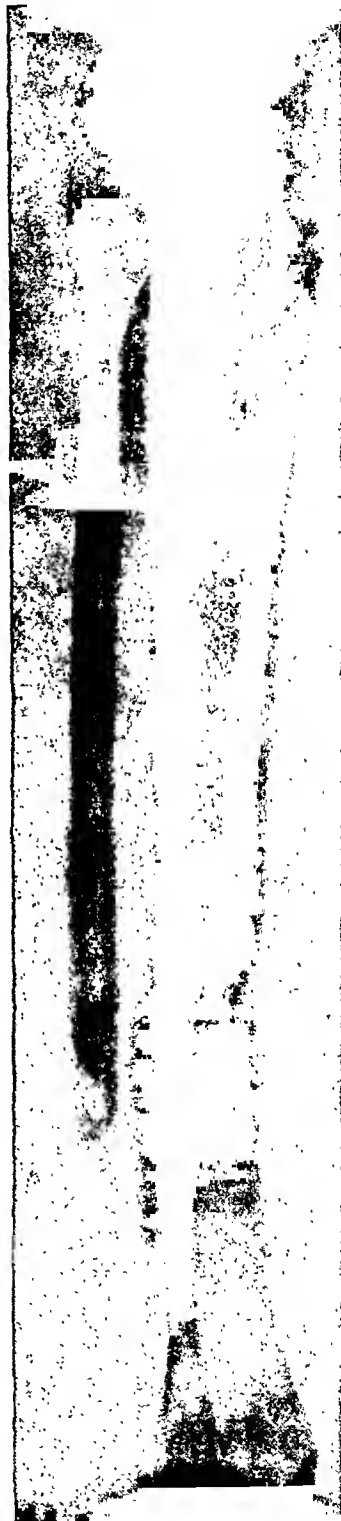


FIG. 2.—The same case showing the mortise, replacement and alignment of the fragments. Two months after the operation the callus was firm and the soft parts nearly healed.

this process appears to be one of the factors in healing, its significance can be ignored neither by the bacteriologist nor the surgeon.

It is to be hoped that the profession will manifest a reasonable and even conservative attitude toward the new facts which are being presented. If medical history repeats itself, the profession will be deluged with "bacteriophage," and the laity will be led to expect marvels from the "new serum." Even a cursory knowledge of the principles will suffice to convince one that the bacteriophage must be specific for the infecting organism. It is not enough to treat a *B. coli* infection with a *B. coli* bacteriophage; the specificity for the infecting strain must be determined in the laboratory. More than that, since it is probable (and from our investigations would seem certain) that the resistance of the infecting organism for the bacteriophage alters during surgical treatment, it cannot be expected that a bacteriophage specific for the infection today will unfailingly affect it a month or six months hence. The effect of the bacteriophage on its homologous strain (short of absolute lysis) is debated by the bacteriologists. When a wound in living tissue is substituted for the test-tube, it is difficult, if not impossible, to foretell the effect of the bacteriophage. In our cases, specificity lasted long enough for us to prepare a bacteriophage following one dressing and introduce it successfully at the next. We were careful, however, to test again for lysis following the treatment, so that we could be sure we had actually administered a potent substance. We do not expect specificity always to endure so long, but we shall at least know our position therapeutically, as far as it can be known with the present knowledge of the lytic principle. At the present time, in our opinion, there is no method of preparing "gun-shot" mixtures of bacteriophages which can be applied scientifically; and no way of applying these principles except with the coöperation of a bacteriological laboratory unless one is content to guess the way in a fog.

While d'Herelle's discovery is of great importance in bacteriology, and may eventually change the present conceptions of infection and immunity, the broad principle is as old as life itself, or almost as old. Since evolution was determined by the struggle for existence, warfare between the old and the new forms of life was probably its first manifestation. Struggle for existence, in the animal kingdom at least, is largely a struggle for mastery or escape. We see only the most evident part of it, but the warfare goes on in the soil, in the air, on the earth and in the waters under the earth. Sometimes victory goes to the swift and the strong, but the eventual master, returning flesh to its primitive elements, and often bringing death to the living, is the microscopic polyphage.

If the individual man is the eventual loser in the struggle, he is probably the gainer collectively. It is the nicely balanced warfare between man's enemies that keeps the earth safe for him. He can live only so long as there is a drawn battle; he survives pandemics, such as influenza, poliomyelitis and encephalitis lethargica, because he is rescued by some unknown foe of his enemy; just as the monsters that would have overwhelmed him before his

history began were destroyed to make way for him. True, some of the protection may have been afforded by the elements or climatic changes, but, in general, it is probable that man's menace eventually meets a menace of its own.

While much of this is speculation, there has been ample proof of the "friendship" of many forms of life for man. It has been applied to the protection of man's food supply. The control of the purple scale, so destructive of fruit trees, depends largely on this principle of letting somebody else fight our battle, and even encouraging him too. This insect pest is attacked by the red-headed scale fungus (which may be a Nordic among the vegetable races). The threads of the fungus ramify through the body of the insect, and eventually kill it as well as most of the eggs it contains. From the insect's point of view this is an awful disease; from ours it is a highly effective and beneficent one. As we eat our citrus fruit we may not suspect what a struggle for existence and what a history of carnage its perfection represents.

There are other forces in this silent battle. If the fungus does not arrive on the field, the lady-beetle attacks this pest. One would never suspect from its appearance that the lady-beetle was capable of such savagery as tearing up the females and eating them. Before the days of bargain sales one would have said there was nothing ladylike about it.

These are examples of the destruction of an insect by a fungus and by another insect. There are many examples of flies being attacked by insects. There is a small insect which lays its eggs within the body of the whitefly, another pest on citrus trees. The grub of the parasite feeds on the host's substance and finally kills it. So effective is this method of attack, and so abundant are the parasites, that the whitefly is destroyed before it can do any material harm. It manages to exist, however, so that the battle, by the latest bulletin, may be considered drawn.

It has been one of the dreams in therapeutics that a natural enemy might be discovered for each germ of disease. There must undoubtedly be one for some of them in nature somewhere, but so far only one has been given serious trial. Some success has attended the use of malaria in the treatment of late syphilis.

The fruit-growers are much more advanced in this respect than we are. They introduce predacious insects to destroy pests, and find the lady-beetle of so much value that they do everything to encourage it to populate their fruit groves. They do not spray trees with chemicals if they can make use of the much more effective living agent. The chemical is more harmful to the lady-beetle than it is to the pest.

These are only a few instances of how man puts his knowledge of biology to practical use. We protect birds and other creatures that destroy pests. In India they domesticate the mongoose for protection from snakes.

It would appear, therefore, that if the bacteriophage is a living creature, as d'Herelle and others assert, it furnishes only another example of the

struggle between natural enemies. The new fact is that it belongs to a form of life about which so little is known and which the bacteriologists are eager to investigate in the hope of discovering the causative agent of some of the unexplained infections. Although the question is still unsettled whether it is a living creature, more is known about it than about ultramicroscopic life in general. Its behavior has been closely investigated; its reactions in the test-tube and in the body have been observed; it has been separated in a comparatively pure state and chemically analyzed; it has even been measured.

As soon as it was definitely shown that there is a bacteriophage in the wounds treated by the Orr method, and that healing was delayed in a case in which the bacteriophage was not present and was accelerated by the introduction of this lytic principle, it was decided to omit germicides so as not to risk the destruction of the bacteriophage at the outset. It is too early yet to determine the results of this change in the technic, but it seems theoretically highly justifiable.

The many advantages of the closed method of treatment of chronic osteomyelitis have been already referred to.<sup>1</sup> Not the least of these is the economy, both in money and time. The patient spends a week, or perhaps a little more, in hospital following the operation. Subsequent changes of dressing are at such long intervals that the patient can remain at home; and the time required for the change is so short, and the reaction so slight that he need remain in hospital only over night.

This consideration is so important from the point of view of the cost of treatment and the necessity of economy of hospital space, that, even if the procedure were not vastly less exacting, it would be preferred by all who have experienced these advantages, even if the ultimate result were no better. As it is, the result, in contrast with those attending older methods, is almost miraculous in the average case.

The whole problem of the bacteriophage is too far from solution for one to hope to draw any sweeping conclusions from the investigation which we have reported. The demonstration of the bacteriophage in the material withdrawn from the lesions of osteomyelitis parallels its original demonstration in the bowel contents in cases of dysentery and in other lesions. We have not been able to concur exactly with d'Herelle that it is found only in the healing stages. It tended to disappear before healing was complete. Our findings may be interpreted, however, so as to parallel d'Herelle's conclusions. It may be that the presence of the bacteriophage indicates the potentiality for healing, if surgical treatment aids instead of interfering with healing.

Under the form of treatment described, the bacteriophage is neither destroyed by chemicals nor dissipated by methods of dressing. It would appear also that the infecting organism, of a variety of types, is reduced in virulence in the presence of its specific bacteriophage, since, although it does not disappear from the wound, it fails to retard noticeably the process of healing if the specific bacteriophage is present. The bacteriophage might,

then, be considered an additional factor in promoting healing of wounds in general and particularly in those of osteomyelitis.

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- <sup>3</sup> Dutton, L. O.: Rôle of the Bacteriophage in Streptococcus Infection. *Jour. Inf. Dis.*, vol. xxxix, p. 48, 1926.
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# CLINICAL EXPERIENCE WITH GASTROPHOTOGRAPHY \*

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IN THE diagnosis of diseases of the stomach and duodenum great reliance has come to be placed upon röntgenologic methods. However highly history, physical examination and analysis of the gastric chemistry may be regarded, the internist and the surgeon are loath to proceed with therapy without obtaining the information derivable from the barium meal—unless such examination is contraindicated by hæmorrhage, impending perforation or evidences of acute obstruction. Time has proven the value of the röntgen-ray examination but also has demonstrated some shortcomings. Small ulcers on the lesser curvature may be missed; larger ulcers and new growths near the cardia and on the posterior wall may be overlooked. It may be extremely difficult or impossible to decide whether a deformity of the stomach is due to an intrinsic or extrinsic lesion.

The gastroscope may give the desired knowledge in some of these problems but because of its risks and unpleasantness gastroscopy has found favor in few hands, particularly as it permits of only a limited range of vision.

The gastrophotor ‡ is an ingenious device invented by Mr. Back, whose researches were begun with Professor Porges and Doctor Heilpern † of the Wenckebach Clinic in Vienna, and continued here in New York. It aims to give the additional information required, providing a greater range than gastroscopy and lacking the unpleasant features. It consists essentially of a semiflexible tube carrying at its distal end two cameras, an upper and a lower, between which is the source of light. This is operated by the transformer and yields a bluish-white flash of 12,000 candle power for 1/120 of a second. Each camera contains four small films circularly disposed, each covering 90 degrees of the circumference by means of two pinholes, upper and lower, and yielding stereoscopic photographs. Thus at one exposure eight double, stereoscopic views are obtained. The fasting stomach is first evacuated by introducing a stomach tube and placing the patient on his left side in the Trendelenberg position, applying suction or positive pressure through the tube (Schindler's method). With the patient sitting up the apparatus is introduced, the stomach inflated with air, the shutter opened, the transformer button pressed, the shutter closed and the apparatus withdrawn. The films are developed and the enlargements (10 times) made for reading. In

\* Presented before the Surgical Section, New York Academy of Medicine, March 7, 1930.

‡ The gastrophotor is made by the Photor Corporation, 386 Fourth Avenue, New York, N. Y.

† *Klinische Wochenschrift*, January 4, 1930, p. 15.



FIG. 1A.—Gastrophotograph. Ulcer of lesser curvature, with œdematous margin, malignant.



FIG. 1B.—Gastrophotograph. Showing furrow on greater curvature produced by operative procedure used in covering perforation.



FIG. 1C.—X-ray taken five weeks after operation for acute perforation, showing large penetrating lesion.

deciding upon the most favorable position for the cameras the knowledge gained as to the shape of the stomach from the X-ray films is utilized. The fluoroscope may be employed for more accurate localization of the apparatus. It is frequently advisable to make an upper (fundal) exposure and a lower (antral) exposure, particularly when the site of the suspected lesion is not known.

The apparatus and films are marked so as to permit of orientation. It is also possible to determine the appropriate size of the lesions, by measuring

the distance between identical points on stereoscopic photographs. Considerable experience is required to read and interpret the pictures. Skill in doing so may best be acquired by checking against operative or autopsy specimens of cases in which the examination has been made. Gastrophotography has been carried out with the aid of Mr. Back in twenty-one cases.

In the following report I present cases in which the result of the examina-



FIG. 2A.—Gastrophotograph. Ulcer on lesser curvature. Antral fold.



FIG. 2B.—X-ray showing hour-glass deformity and niche on the lesser curvature.



tion has been subjected to the test of surgery or post-mortem investigation, submitting illustrations of the X-ray findings, the gastrophotographs and the specimens.

CASE I.—H. K., Hosp. No. 307455. A man of sixty-one years with an eight-year history of remittent periods of typical ulcer pain was admitted October 8, 1929, with epigastric tenderness and rigidity. The symptoms and signs of perforation appeared on October 10, free air under the diaphragm being demonstrated by X-ray. At operation I found on the anterior wall of the stomach just below the œsophageal entrance and involving the lesser curvature, an indurated lesion five centimetres in diameter, at the centre of which was a small perforation. The site of the lesion made resection inadvisable. Because of the œdema and infiltration the perforation had to be covered by bringing the uninvolved anterior wall near the greater curvature up over the lesion, greater omentum was used as a second suturing it to the lesser omentum. The barrier. The patient recovered but was subsequently readmitted for recurring ulcer symptoms, which yielded at first to medical treatment directed by Doctor Grohn.

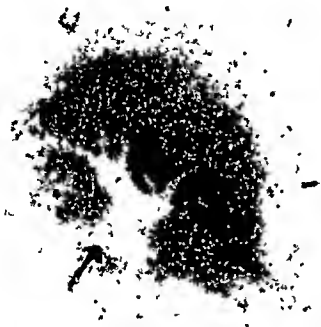


FIG. 3A.—Gastrophotograph. Carcinomatous ulceration.

When symptom free a gastrophotograph was made December 4, 1929. This showed (Fig. 1A) an ulcer on the lesser curvature about one and a half inches in length surrounded by an œdematous raised area. There was also seen (Fig. 1B) a longitudinal furrow on the greater curvature caused by the plication which had been used to cover the perforation. An X-ray study was made five weeks later (Fig. 1C).

Subsequently recurring symptoms and loss of weight, after the initial remarkable gain, enforced surgical intervention (March 5, 1930). A large penetrating lesion of the lesser curvature above the re-entrant angle and juxtaœardial in location was found. The resected specimen proved to be carcinomatous.

CASE II.—J. D., Hosp. No. 224674. Admitted in November, 1922. This man of fifty-six had a three months' history of anorexia and epigastric pain. Ewald test meal showed free acid, 30, total 55. Barium meal revealed a large penetration on the lesser curvature. At exploration Doctor Lewisohn found a large lesion which he considered an inoperable ulcerated carcinoma at the site indicated by the X-ray. An omental nodule removed for section showed no evidence of cancer. The clinical diagnosis of malignancy was proven erroneous by subsequent events.\*

In June, 1924, the patient had lost no weight, was practically free of symptoms and X-ray examination showed only a small niche high up on the lesser curvature. In 1925 the stomach presented an hour-glass deformity and a minute niche just below the cardia. In 1928 the niche had disappeared. The man has remained in good general condition and is practically free of symptoms. He recently submitted to gastrophotography. This showed a large ulcer on the lesser curvature (Fig. 2A), partly obscured by a curtain-like fold which is probably the antral fold or sphincter drawn upward and accounting for the hour-glass appearance observed in the X-ray films. The photograph indicates that despite absence of symptoms the lesion has again become active.

An X-ray examination made on March 4, 1930, showed an organic hour-glass

\* Doctor Lewisohn has reported this case in the ANNALS OF SURGERY, 1926, vol. lxxxiii, p. 466.

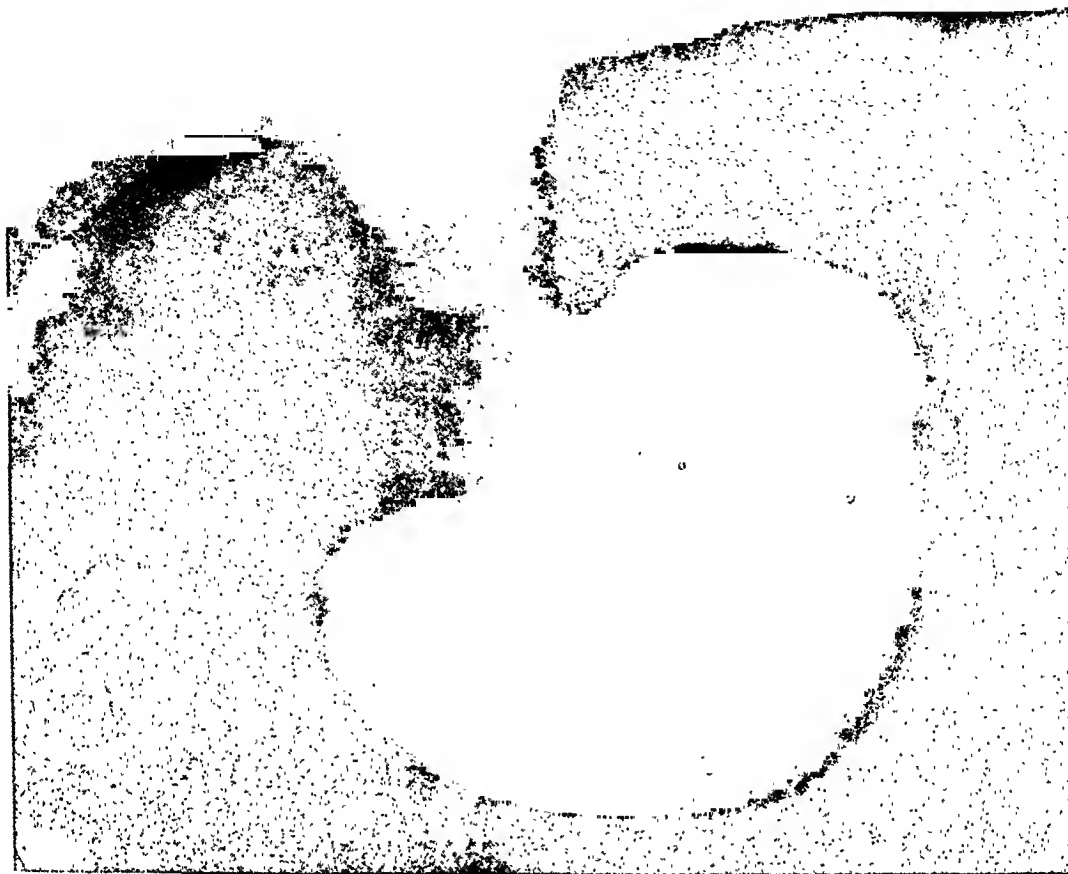


FIG. 3B.—X-ray. Pyloric obstruction, deformity of bulb.

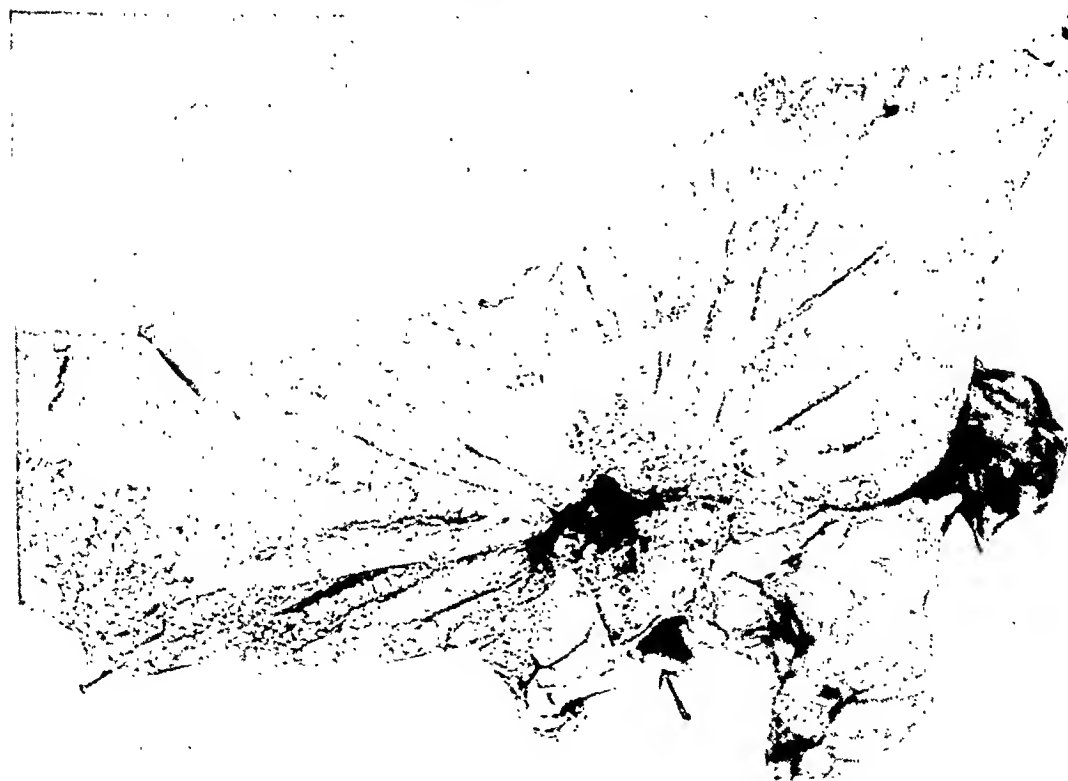


FIG. 3C.—Resected stomach. Prepyloric carcinoma ulceration.

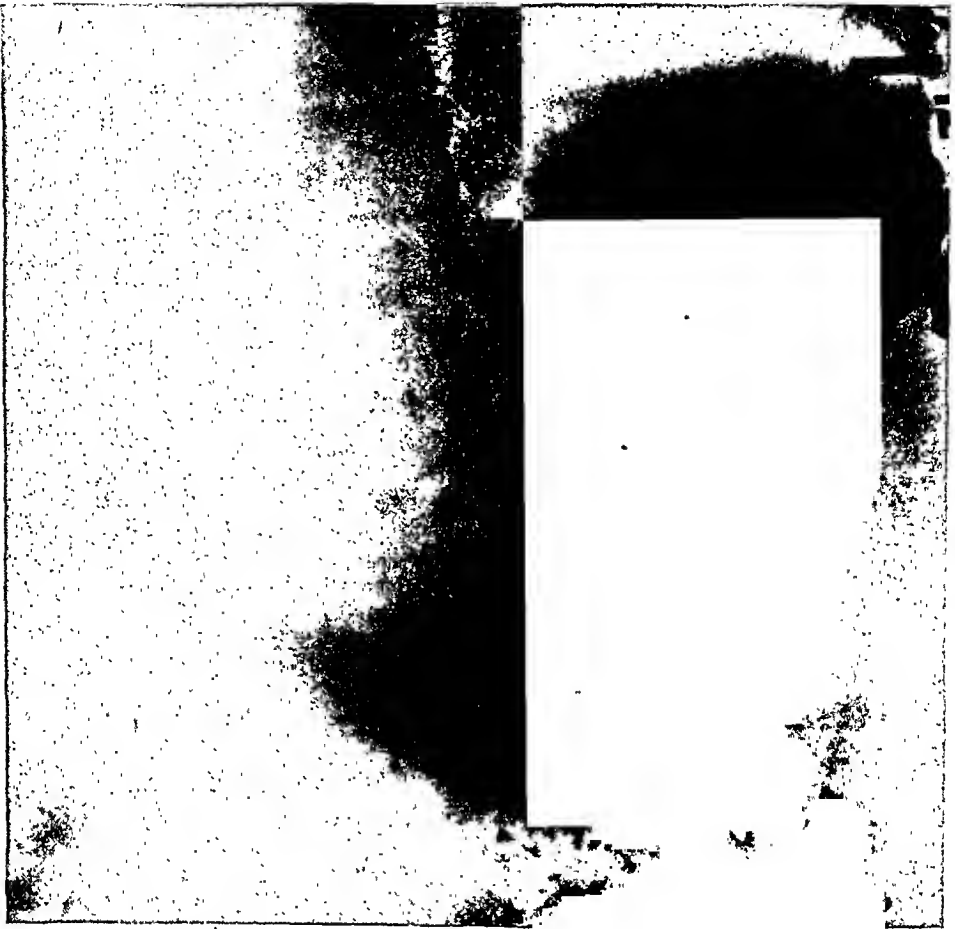


FIG. 4A.—X-ray. Deformed stomach. No niche demonstrable.

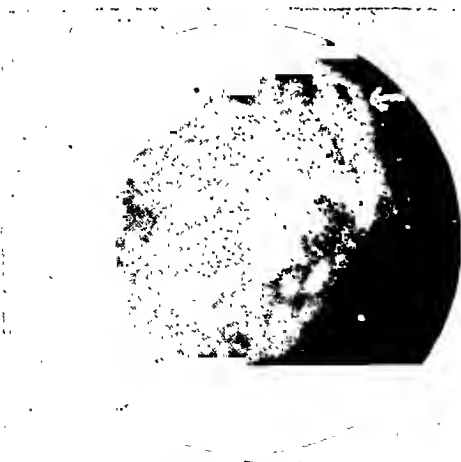


FIG. 4B.—Gastrophotograph. Ulcer of lesser curvature.

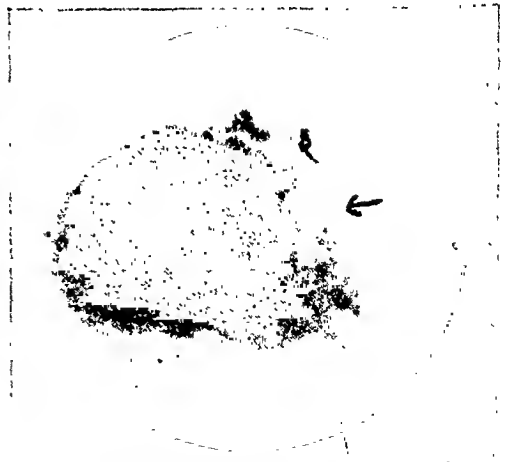


FIG. 4C.—Gastrophotograph. Gastritis of posterior wall.

deformity of the stomach with a projection from the lesser curvature opposite the incisura (Fig. 2B).

CASE III.—S. K., Hosp. No. 308020. A woman of fifty-five years, with eight months' history of epigastric pain, vomiting, hæmatemesis and melæna, loss of weight and strength. Despite treatment she became worse and developed gastric retention. Gastrophotography December 4, 1929 (Fig. 3A), showed a deep, cratered ulcer with irregular, heaped-up margin about one and a half inches in diameter. It was allocated to the greater curvature and considered to be carcinomatous. X-ray examination December 10, 1929, showed a large dilated stomach, poor tonus, deformed bulb and large residue (Fig. 3B); the diagnosis was duodenal ulcer. Operation December 18, 1929, revealed a large carcinomatous crater involving the lesser curvature of antrum

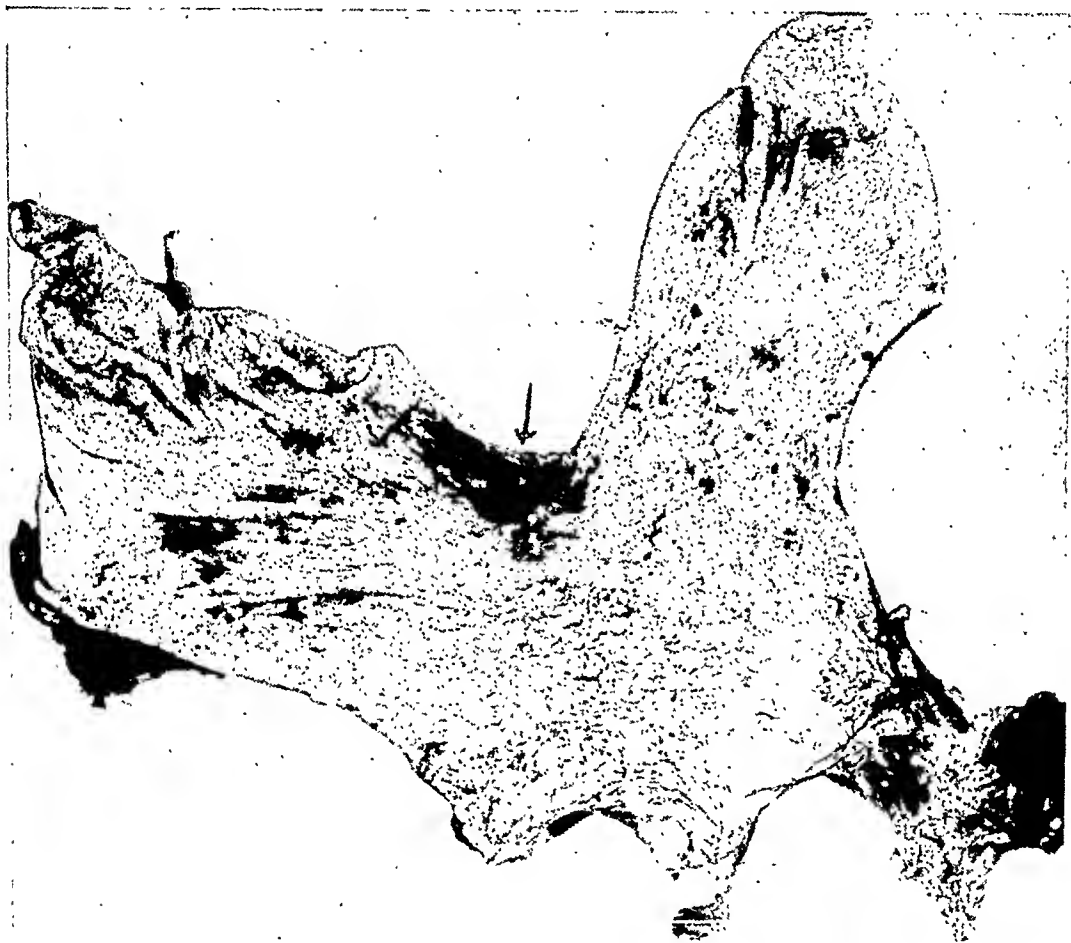


FIG. 4D.—Resected stomach. Ulcer at re-entrant angle.

and pylorus. The specimen resected by Doctor Berg (Fig. 3C) shows that the lesion corresponds to the gastrophotograph. It seems that the error in localization was caused by incorrect marking of the films.

CASE IV.—B. C., Hosp. No. 309621. A man of forty-two years following an injury was operated upon in 1916 for a perforating lesion of the stomach (ulcer?). In 1920 he began to have pain coming on two hours after meals and relieved by food. In 1923 the gall-bladder was removed without relief of symptoms. In 1924 another surgeon explored for suspected duodenal ulcer, but discovered only extensive perigastric adhesions. There was no relief, and he came to this service December 14, 1929. Fractional test meal yielded free acid 20, total acid 24. Barium meal showed a deformed, somewhat hour-glass-shaped stomach; no niche demonstrable (Fig. 4A). Gastrophotography showed an ulcer on the lesser curvature (Fig. 4B) and evidences of gastritis on the posterior wall (Fig. 4C). Operation revealed a stomach imbedded in adhesions with an ulcer at the re-entrant angle. The specimen resected by Doctor Berg is shown in Fig. 4D.



FIG. 5A.—X-ray. Prepyloric annular defect.



FIG. 5B.—Gastrophotograph. Small ulcer on lesser curvature.

## CLINICAL EXPERIENCE WITH GASTROPHOTOGRAPHY

CASE V.—S. P., Hosp. No. 309629. A man of thirty-six with two years' history of left epigastric pain radiating into the dorsal region, especially severe at night. Food and alkalis afforded relief until four months ago since when the pain had become persistent and more intense. Fractional test meal showed free acid of 60, total 96. Barium meal revealed a persistent prepyloric annular defect indicative of neoplasm (Fig. 5A). Gastrophotography showed a small ulcer on the lesser curvature (Fig. 5B). At operation Doctor Berg found extensive perigastric adhesions and a mass in the pyloric region. Resection was carried out above the re-entrant angle. On opening the specimen the pyloric mass proved to be a greatly hypertrophied pyloric musculature, but a small ulcer corresponding to that seen in the gastrophotograph was present on the lesser curvature near the proximal line of resection (Fig. 5C).

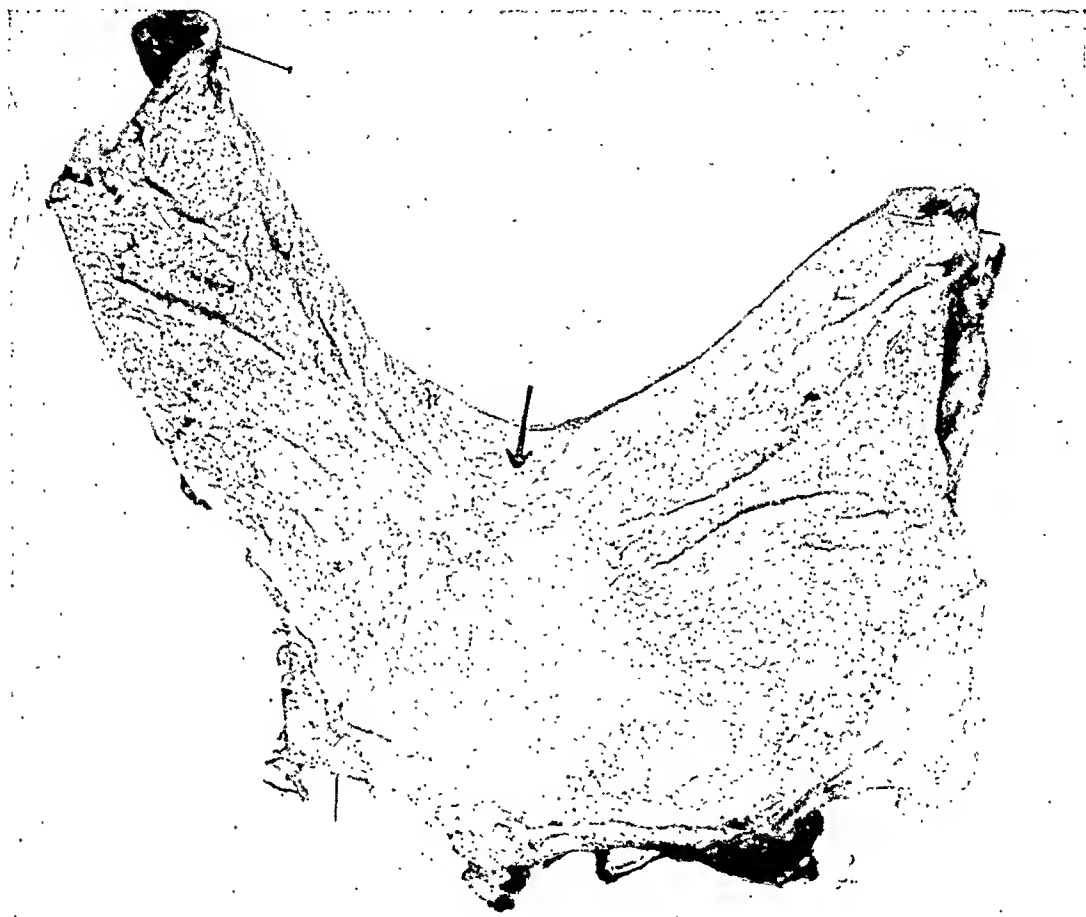


FIG. 5C.—Resected stomach. Hypertrophic pylorus. Small ulcer at re-entrant angle.

CASE VI.—C. R., Hosp. No. 309728. A man of fifty-nine suffered for one year with severe pain radiating from epigastrium to left lower chest and back, coming on two hours after meals, relieved at first by food and alkalis. Then pain became intractable, he lost weight and strength. Melæna occurred. Carcinoma was suspected. Gastric analysis yielded no marked deviation from the normal. Gastro-intestinal X-ray had to be made with the patient recumbent and although there seemed to be a small niche at the re-entrant angle the radiologist would make no definite diagnosis (Fig. 6A). The gastrophotograph (Fig. 6B) was suggestive of an ulcer at the lesser curvature but this also was not definite. At exploration I found a small indurated area at the re-entrant angle and resection was carried out with complete relief. The specimen presented (Fig. 6C) a small ulcer about four millimetres in diameter.

CASE VII.—M. G., Hosp. No. 301857. A man of forty-eight with thirteen years' history of epigastric pain at first relieved by food but becoming more persistent and intense. In April, 1929, he was explored by me although X-ray investigations of kidneys,



FIG. 6A.—X-ray. Recumbent position. Questionable niche.



FIG. 6B.—Gastrophotograph. Questionable lesion of lesser curvature

gall-bladder and gastro-intestinal tract were negative. At this time I had not begun using the gastrophotor. Exploration proved negative. Broncho-pneumonia supervened and as a result of coughing the wound ruptured.

In November, 1929, he returned for renewed and aggravated epigastric pain with radiation into the back and vomiting. A large incisional hernia was repaired without exploration of the viscera. Five weeks later he was readmitted for persistent severe pain and melena. He had lost weight. There was tenderness in the left upper quadrant. Fractional meal showed free acid 75, total 120. Stomach contents and stools contained occult blood. Barium meal revealed a defect involving the antral and prepyloric areas with formation of a large irregular penetrating lesion extending almost to the cardia. The radiologist reported neoplasm of the stomach (Figs. 7A and 7B). Gastrophotography



FIG. 6C.—Resected stomach. Small ulcer at re-entrant angle.

showed a large crater on the lesser curvature and posterior wall with an irregular moth-eaten margin (Fig. 7C). At operation a huge, penetrating, carcinomatous ulceration was found. It is apparent that a small lesion was missed at the first exploration and that it had rapidly progressed. It is in such cases with negative X-ray findings that this new method may yield important and helpful information.

CASE VIII.—L. P., Hosp. No. 310740. A man of forty-eight in excellent health until three months ago, noted epigastric pain radiating to the left hypochondrium, persistent and not related to food intake. Fractional analysis showed free acid 50, total 64, with blood in all specimens. Barium meal revealed a large penetrating lesion at the re-entrant angle, one and a half inches in diameter (Fig. 8A). At six hours some barium was still present in the pocket. The gastrophotograph showed an elliptical punched-out ulcer on the lesser curvature or posterior wall. It appears in the illustration one-third to one-fourth the natural size (Fig. 8B). At operation a large penetration was found extending from a crateriform lesion of the lesser curvature and posterior wall. Resection was carried out and the specimen proved to be an adenocarcinoma (Fig. 8C and Fig. 8D).



CASE IX.—M. G., Hosp. No. 306972. This man of sixty-two had a posterior gastrojejunostomy performed by Doctor Lewisohn, at the Beth Israel Hospital, in 1913, for an ulcer at the pylorus. In 1920 at Mount Sinai Hospital, he had clinical and X-ray evidence of gastrojejunal ulcer. Relieved by medical management, he was discharged. In the summer of 1929 he came to the out-patient department of the Sydenham Hospital,\* complaining of postprandial pain, pyrosis, vomiting and rapid loss of weight. Fractional meal showed free acid 60, total 135. Barium meal revealed a large stomach, exaggerated peristalsis, considerable retention and pyloric obstruction attributed to neoplasia or



FIG 7A—X-ray. Antero posterior. Irregular antrum

adhesions. A gastrophotograph made soon thereafter showed a crateriform ulcer on the lesser curvature with mucosal folds radiating from it, suggesting that the lesion was in the prepyloric area (Fig. 9A). On September 24, 1929, he again entered Mount Sinai Hospital, where X-ray examination showed pyloric obstruction, gastric retention, and a poorly-functioning stoma with a patch of barium indicating a jejunal ulcer (Fig. 9B). While under observation he developed signs of acute perforation. At operation Doctor Lewisohn found a pin-point opening in the jejunum near the old stoma, and a large subhepatic abscess. The perforation was closed and jejunostomy performed. He ceased the next day. The post-mortem examination showed a healed pyloric ulcer with stenosis, a large chronic peptic ulcer on the lesser curvature, prepyloric in location, and a repaired perforation of a jejunal ulcer which had caused obstruction at the stoma.

\* I am indebted to the Sydenham Hospital for the use of its record in this case.



FIG. 7B.—X-ray. Oblique. Large irregular penetration.

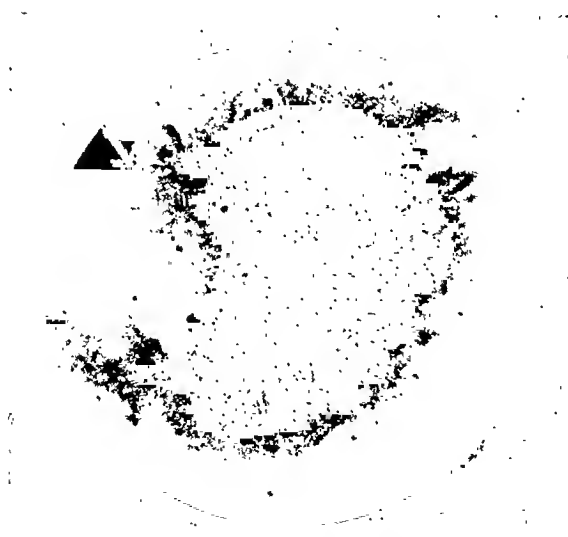


FIG. 7C.—Gastrophotograph. Large crater with irregular moth-eaten edge.



FIG 8A —X ray. Large penetration

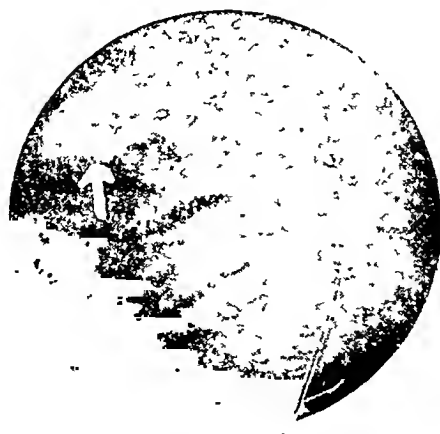


FIG 8B —Gastrophotograph Mouth of the penetration, one fourth the natural size

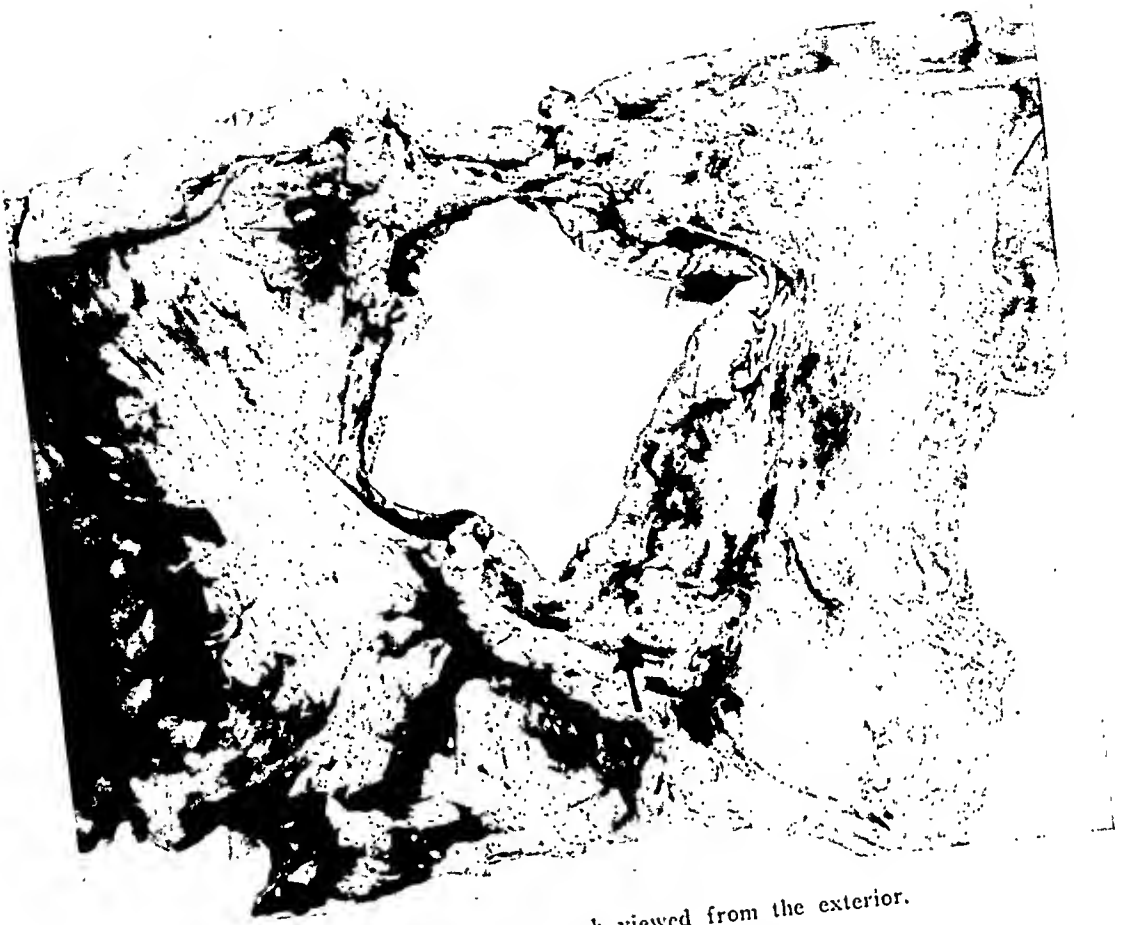


FIG. 8C.—Resected stomach viewed from the exterior.



FIG. 8D.—Resected stomach viewed from the interior, showing crater.

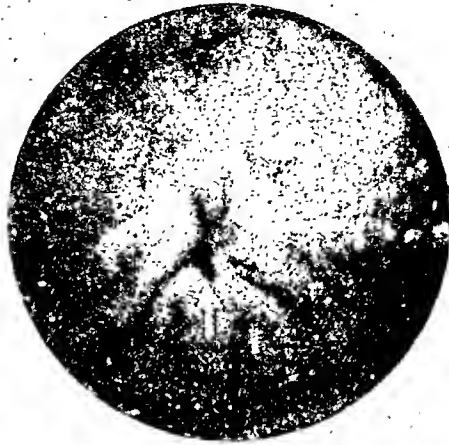


FIG. 9A.—Gastrophotograph. Ulcer of lesser curvature.



FIG. 9B.—X-ray. Pyloric obstruction, poorly functioning stoma.



FIG. 10A.—Gastrophotograph. Ulcer.

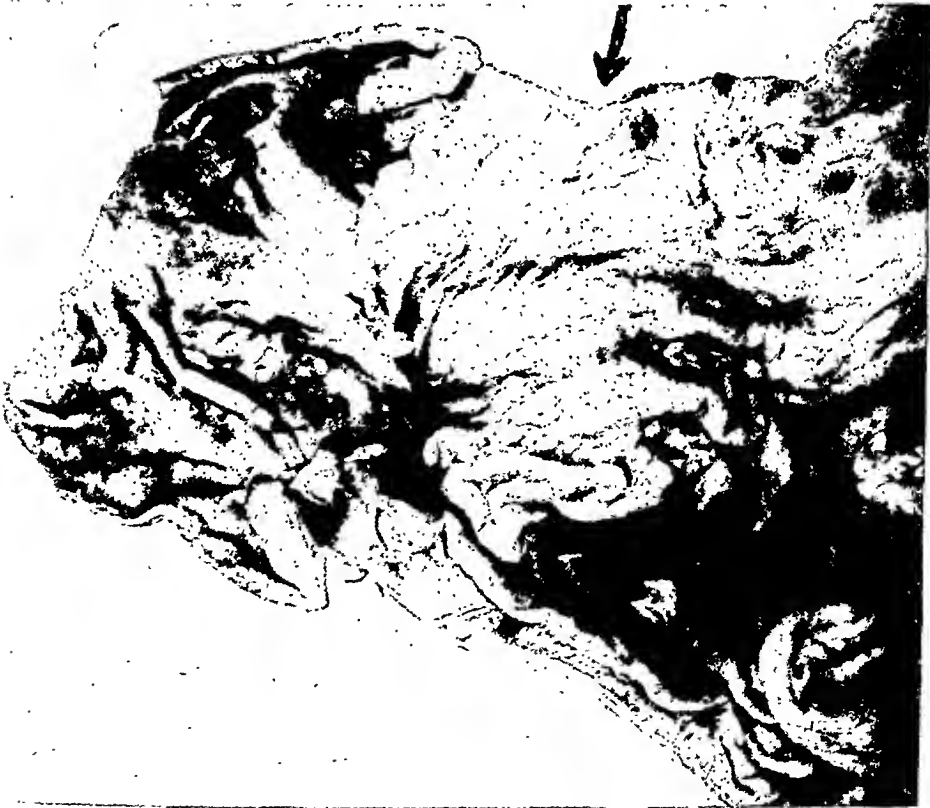


FIG. 10B.—Autopsy specimen showing corresponding lesion of antrum.

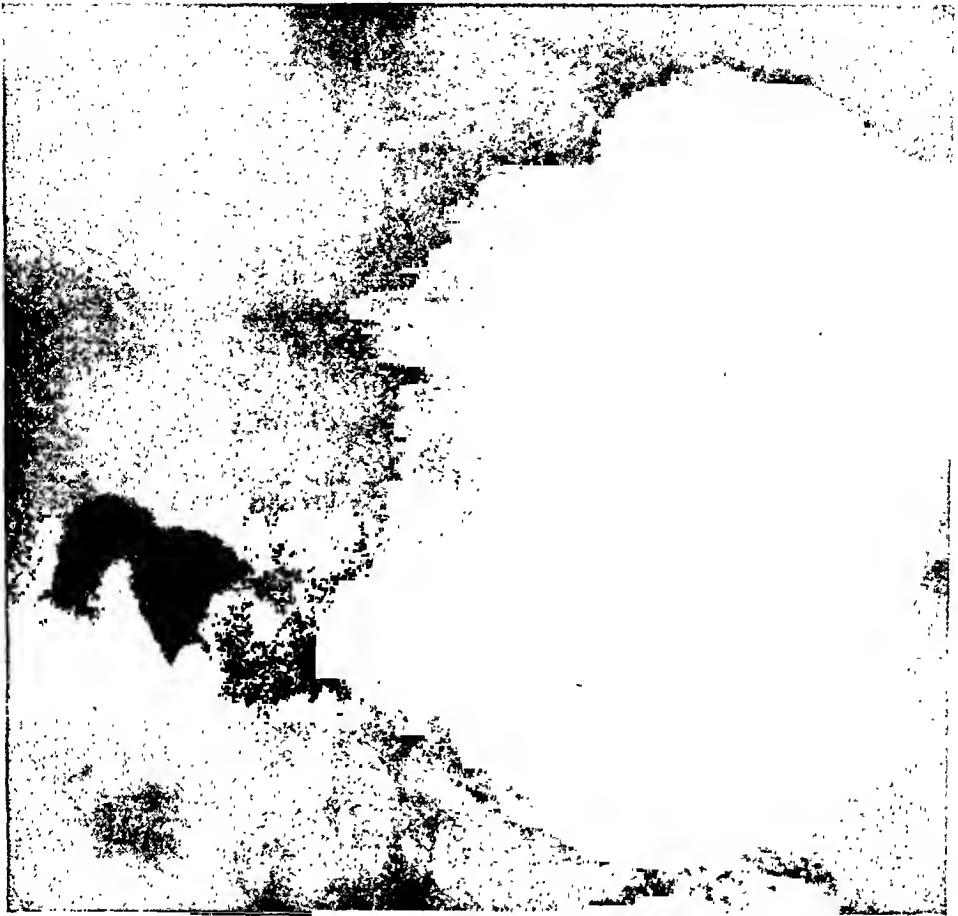


FIG. 11A.—X-ray. Large irregular filling defect of antrum.

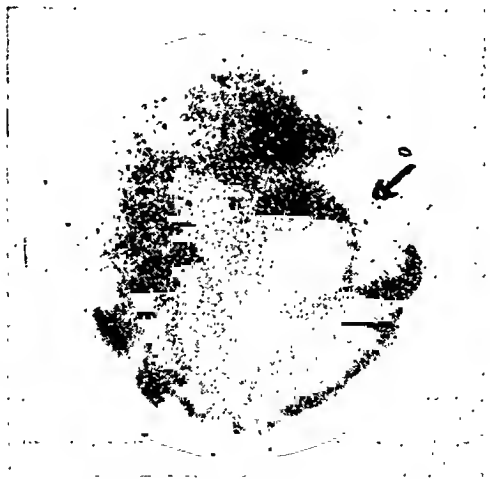


FIG. 11B.—Gastrophotograph. Fungating carcinoma of greater curvature.

## CLINICAL EXPERIENCE WITH GASTROPHOTOGRAPHY

CASE X.\*—B. S., aged sixty-nine years, complained of pain in left upper quadrant two hours after meals, with periods of remission, for eight years. Three months ago the symptoms returned with greater severity and were not relieved by diet or medication. Ewald meal showed free acid 20, total 60. X-ray examination showed nothing definite in the stomach; the duodenum was normal. The prepyloric region was tender. Gastrophotography revealed a definite ulcer (Fig. 10A). The patient was explored but no ulcer found, although the surgeon, a man of skill and wide experience, did a gastrotomy for inspection and palpation. About five days later the patient died of cardiac failure. A post-mortem examination showed a small callous ulcer on the lesser curvature about 4 centimetres proximal to the pylorus. Its crater was about 1.0 times 0.5 centimetres in size, and the serosal surface of the stomach showed no gross changes at the site of the lesion (Fig. 10B).

CASE XI.—S. L., Hosp. No. 309378. A man with six months' severe, constant, epigastric pain followed by loss of weight and strength, anaemia and oedema. A large mass presented in the epigastrium. There was marked gastric retention and achlorhydria. Barium meal showed a large irregular filling defect of the lower two-thirds of the stomach (Fig. 11A). Gastrophotographs showed a large fungating carcinoma involving the anterior wall and greater curvature (Fig. 11B). No operation was performed as the case was too far advanced.

The results of X-ray and gastrophotography employed in twenty-one cases may be summarized as follows:

1. X-ray diagnosis and gastrophotography agreed in nine cases. Of these the diagnosis was correct as checked by operation in six cases. Not submitted to operation: three cases of carcinoma, considered clinically inoperable.
2. X-ray diagnosis and gastrophotography disagreed in six cases. Of these the X-ray diagnosis was proved correct by operation in one case, duodenal ulcer. Gastrophotography was proved correct by operation in three cases. Gastrophotography was proved correct by autopsy in two cases.
3. Neither method yielded a positive diagnosis in one case, a very small ulcer at the re-entrant angle.
4. Not submitted to exploration as yet, five cases.

### CONCLUSIONS

Gastrophotography is a valuable adjunct in the diagnosis of lesions of the stomach. Of twenty-one cases examined, thirteen were checked by operation or autopsy and of these gastrophotography gave more reliable information than the barium meal in five cases. The natural limitations of the method preclude obtaining direct evidence in lesions of the duodenum and jejunum. Here the röntgen-ray method must be relied upon at present.

As to the benign or malignant nature of a large ulcer, absolute conclusions cannot be drawn from either the X-ray or the gastrophotograph. In any patient suspected of a gastric lesion, gastrophotography should be employed despite positive, doubtful or negative X-ray findings. A more extended application of the method is highly desirable, for the results thus far obtained surely indicate that it has real merit.

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\*I am indebted to Dr. R. Finkelstein, gastroenterologist of the Brownsville and East New York Hospital, for the privilege of reporting this case.



# SIMPLIFIED TREATMENT OF THORACIC EMPYEMA\*

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FROM THE MEDICAL DEPARTMENT OF THE UNIVERSITY OF TEXAS

THE basis for this paper has been a study of a series of eighty-one consecutive empyemas treated in the Surgical Service of the John Sealy Hospital, Galveston, Texas. It does not include a number of untreated terminal cases which occurred in the medical service, or cases found at autopsy complicating some other serious disease. Tubercular empyemas also have been excluded.

Practically all of these were preceded by pneumonia or influenza. It is safe to say that pneumonia is less common in the far South than in the more northern states, and there is also a decidedly lower mortality, with correspondingly fewer cases complicated by empyema. The mortality in this series of cases, as compared to reported statistics available from institutions elsewhere, is generally lower. This is likely due to the milder pneumonia, or may be to the method of treatment.

The accompanying chart shows the mortality in this series:

*Eighty-one Cases of Empyema as to Age, Sex and Result*

Age	Result			Mortality, per cent
	Recovered	Died	Total	
Under 5 years.....	12	1	13	7.6
5 to 20.....	27	0	27	0
20 to 40.....	23	1	24	4.2
Over 40.....	14	3	17	17.6
Total.....	76	5	81	6.3

Males, 58; females, 23.

The cause of death in our series was as follows:

CASE I.—A child, age fourteen months, female, colored. The child had never been properly nourished. She entered the hospital with a history of an injury one week before and was found to have the right chest full of pus, an abscess in the cellular tissues of the orbit, and an abscess about the median end of the clavicle. The abscesses were opened and the empyema drained. The child was very septic with pyemic abscesses and died of exhaustion sixteen days after admission. Autopsy findings showed the following: Fibro-purulent pleurisy, bilateral; purulent arthritis of the left sternoclavicular joint, also osteomyelitis of the fifth, sixth and seventh ribs, bilateral septic pneumonia, acute entero-colitis, acute splenic tumor and cellulitis of the right eye.

CASE II.—A man thirty-four years of age. The patient's trouble began with a

\* Read before the Southern Surgical Association, December, 1929.

## SIMPLIFIED TREATMENT OF THORACIC EMPYEMA

peri-urethral abscess complicating a stricture of the urethra, which was drained; and his convalescence was very slow. He returned to the hospital several weeks later with a well-developed empyema (streptococcic organisms were found) and there was an abscess underneath the skin where his chest had been previously aspirated. A rib was resected and drainage instituted. The abscess cavity continued to drain and the patient's health remained poor for about a year. A chronic sinus continued present in the perineum. At this time the patient attempted suicide by cutting his throat just below the hyoid bone and into the pharynx, and developed septic pneumonia, dying shortly afterward. Autopsy findings were a self-inflicted wound of the neck; large sinus in the left side communicating with pyogenic membrane over the lung, acute purulent bronchitis, right side, enlarged spleen, chronic cirrhosis of liver and acute glomerulonephritis.

CASE III.—Male sixty-five years of age. The patient entered the hospital with anasarca from cardiovascular disease and on examination he was found to have œdema of feet, a heart murmur, dilated heart, fast pulse and the right side dull. Aspiration

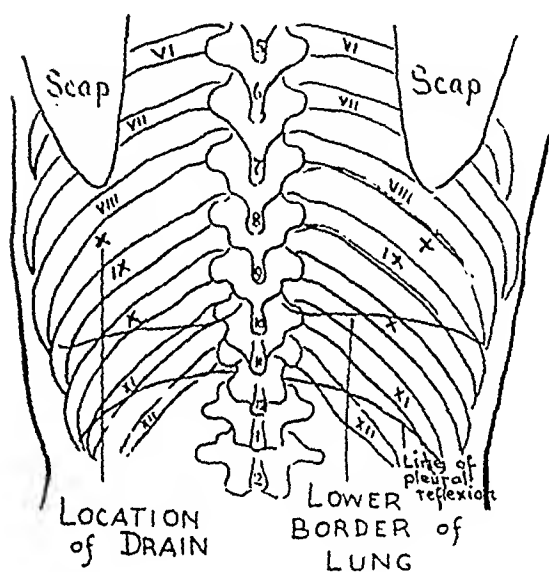


FIG. 1.—(X) indicates location of drain.

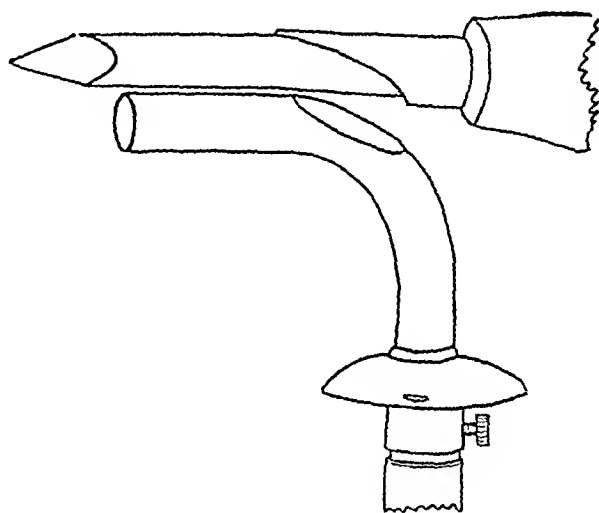


FIG. 2.—Trocar and cannula. Cannula left in place sutured to skin.

showed pus. A drainage tube was inserted and the second night afterward the patient in some way got the drainage tube out of his chest. A rubber tube was inserted, and there drained a large quantity of pus until he died three weeks later. No autopsy secured.

CASE IV.—Female, age forty-five years. The patient entered the medical service with lobar pneumonia on January 28th. Following a stormy pneumonia she developed empyema, and on April 19 she was transferred to surgery with a diagnosis of empyema of the right side. She had been spitting considerable pus for several days. She was drained the next day. The patient suffered much pain, her pulse became weak and she died April 29 (nine days after drainage). Autopsy findings showed atheromatous aorta; empyema, right; infarct of spleen; hæmorrhagic pancreatitis; pneumonia of the left lower lobe; acute nephritis.

CASE V.—A colored woman, fifty-three years of age. The patient came into the hospital with an empyema of the right side. She was cold and clammy; pulse 120-140, and almost uncountable. She was delirious, tossing about, tearing off bandages, and never controllable. She had to be forced to take her food by nasal feedings. Delirium continued and a toxic diarrhœa developed. She never improved, living fifteen days after drainage. An autopsy was not secured.

## CONSIDERATIONS BEARING UPON

*Treatment.*—There are many things to be considered in treating empyema. Bacteria which produce the suppuration are quite a determining factor in the mortality as well as in the treatment. Those cases of streptococcic origin, which often occur early in the pneumonia, are more serious than the pneumococcic types which usually follow the pneumonia and occur after quite a degree of resolution has occurred in the lung. Also those cases which are drained with the lung in a crippled condition will have a higher death rate than those drained after a period of delay, until the lung is not so greatly embarrassed by consolidation, and is able to maintain a larger amount of tidal air.

It is unnecessary to state that drainage is the treatment for a frank pleural suppuration, but the question of when drainage should be restored to is debatable. The very high death rate from empyema in the various camps during the late war was quite noticeable. The empyema commission,



FIG 3—Trocar and cannula with rubber tube attached      FIG 4—Home made drainage tube which is used after cannula is removed

at some of the military camps, observed that early drainage was followed by a higher mortality than delayed drainage. Also that chronic empyema and blood-stream infection were more likely to follow early drainage. A delay in drainage is unquestionably preferable because of the following reasons. First, it allows useful adhesions to form between the lung and the parietal pleura, and, therefore, less retraction of the lung will take place after drainage. Second, as Graham has pointed out, the mediastinum is very flexible normally and delay allows the mediastinum to become more fixed by inflammation and adhesions, and the function of the normal side of the chest is not disturbed to so great an extent after drainage. Third, further resolution in the diseased lung will take place, insuring better lung function at the time of drainage. Fourth, repeated aspiration and drainage delayed from seven to ten days allow the development of an immunity to the infection, and upon this self-immunizing process probably depends the recovery of empyema, as well as all other diseases of an infectious nature.

## SIMPLIFIED TREATMENT OF THORACIC EMPYEMA

*Open vs. Closed Drainage.*—While rib resection with open drainage has been and still is the favorite method, on the other hand there is a growing tendency to use some form of closed drainage.

The first suction drainage apparatus for empyema was used by Brilan, of Vienna, in 1890. Perthes also in 1901 used a closed method with intermittent suction. Of the many advocates of closed drainage, the following reports will indicate the trend to this method. McKenna<sup>1</sup> reports nineteen adults treated without a death by trocar and cannula and catheter by repeated aspiration with a syringe. Mozingo<sup>2</sup> reports sixty-nine cases of acute empyema with three deaths treated by trocar and tube, and suction with syringe with the use of Dakin's solution, glycerine and carbolic acid. Alexander<sup>3</sup> uses a closed method of drainage with the tube entering the chest obliquely through

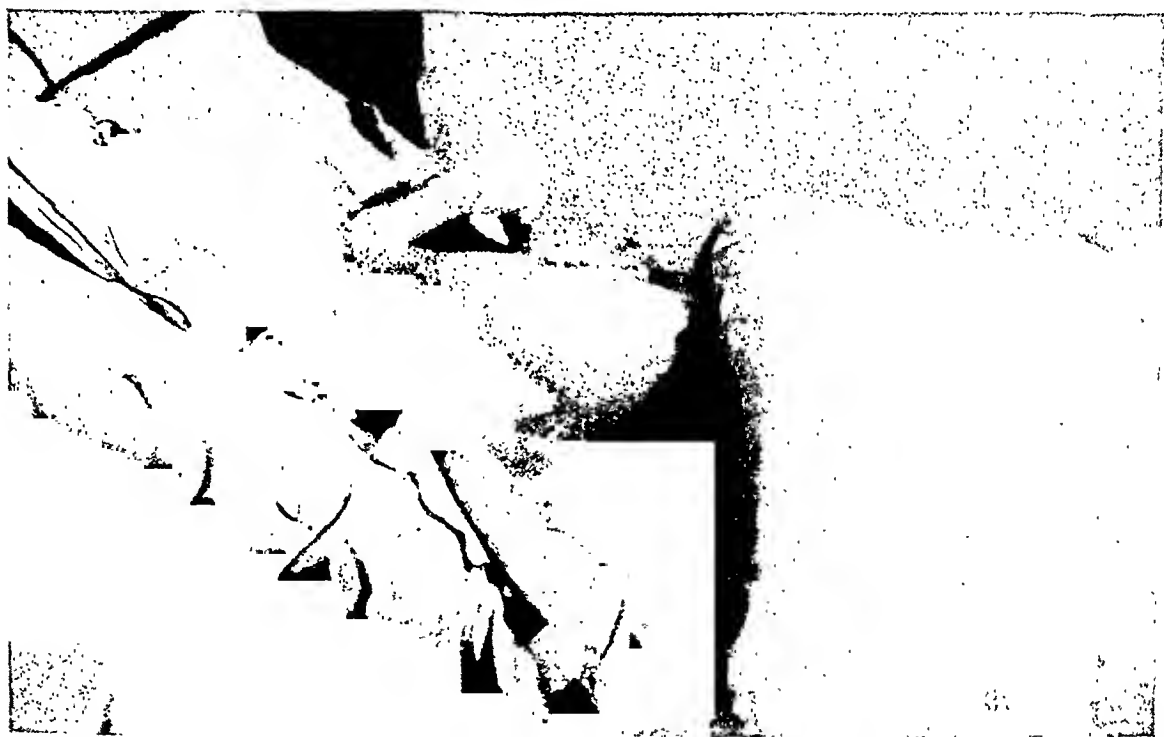


FIG. 5.—Drainage completed. Tube filled with water and end placed under water causing syphonage drain.

the chest wall. Hart<sup>4</sup> uses a closed method with continuous tidal irrigation with a special apparatus. Soresi<sup>5</sup> uses an apparatus with a valve producing a closed drainage with wonderful success. Freed<sup>6</sup> reports from the U. S. Veterans Hospital a study of one hundred cases. He says, "Men operated upon by the open method have at the expiration of so long a period more disability, and in some instances, they are totally incapacitated, and further, the open method with its numerous modifications, whether it be costocetomy or thoracotomy is gradually becoming more in disuse for some form of occlusion treatment." Davis<sup>7</sup> uses a pneumatic bag to keep the cavity air-tight with closed drainage. Parton<sup>8</sup> describes a rather simple apparatus for continual suction over a long period of time. Hart<sup>9</sup> has devised an ingenious apparatus which produces tidal irrigation and drainage dependent upon normal respiratory moments. McGlannan,<sup>10</sup> Whitte-

more,<sup>11</sup> Ransohoff,<sup>12</sup> and others have written excellent articles and reported results highly favorable to the closed methods of treatment.

*Method of Drainage.*—For a number of years we have practised a modified closed method of drainage (Figs. 1-6) and the eighty-one cases reported, with the exception of one rib resection, have been treated in this way. In four small infants an 18 F. rubber catheter was placed into the chest between the ribs with an ordinary trocar and cannula, while in all other cases the trocar and cannula drain here illustrated was used. This treatment was developed in the service some eight years ago during the administration of Dr. J. E. Thompson. There are two sizes of the tube, one for children and one for adults. The trocar and cannula are inserted

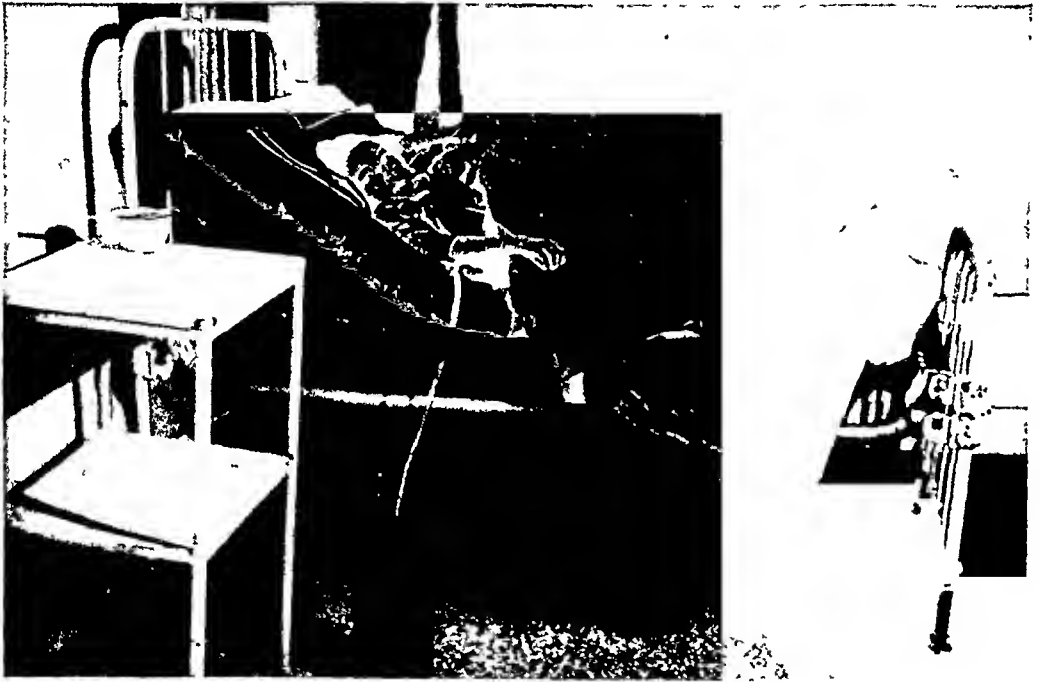


FIG. 6.—Drainage completed.

between the ribs and the cannula remains in place stitched to the skin. Tube connection filled with sterile water is led to a large bottle beside the bed and the end placed under water, thus retaining a vacuum, with a siphon effect. The pus is allowed to escape gradually for the first twenty-four hours by clamping and unclamping the tube. The vacuum is maintained for eight to ten days, when leaking of air around the cannula occurs. At this time the cannula is removed and a rubber tube here illustrated of the same size as the cannula is substituted. This drain cannot slip within the chest and does not protrude so that the dressing presses upon its end. It is well to have two or three of the rubber tubes prepared so that they may be changed. The tubes should not be left out until the cavity is practically obliterated, which can be told by measuring its capacity with water, or by lipiodol and X-ray plates.

Local anæsthesia is always used, even with infants. The intercostal nerves in the space drained, and one rib space above and below are blocked with novocain proximal to the wound. Also one to two cubic centimetres of alcohol are used to block the intercostal nerve of the space drained that the pain from the pressure of the cannula will not trouble for several weeks.

The position selected for the drainage is one rib space below the angle of the scapula and directly below. The space is selected because it is the most dependent portion of the chest with the patient in the reclining position, and also we have found that in chronic empyemas the persistent cavity is at this location and high up along the angle of the ribs. It is important to have the arm to the side when the operation is done. If the incision is made with the arm above the head, the opening in the skin and that of the chest wall will not correspond when the arm is brought to the side.

We are not in a position to say that this method of drainage gives better results in every instance than the open rib resection. Undoubtedly rib resection has a place in certain cases, but we have been better satisfied since adopting this method as a routine. Thus far we have had one chronic empyema resulting, necessitating radical operation. (This case was reported under the deaths.) Two of the series drained for one year and then closed without further treatment. An occasional chronic case we believe may result from any method of treatment. This method can be recommended for its simplicity. It can be done while the patient is in his bed with a minimum amount of operating and slight disturbance to a very sick patient. The closed method of drainage possibly results in some expansion of the lung as the fluid escapes, and does not encourage further retraction of the lung as the open drainage would seem to do. Again osteomyelitis does not occur as is occasionally seen after rib resection. The cannula is non-collapsible, and a suitable tract is left for a large rubber tube when the cannula is discontinued.

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# AMYTAL AS AN ANÆSTHETIC IN OPERATIONS FOR GOITRE

THE ORAL ADMINISTRATION OF BARBITURIC ACID COMPOUNDS \*

By HARRY G. SLOAN

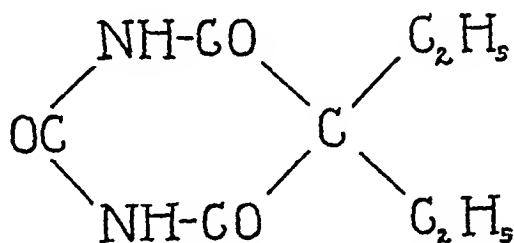
OF CLEVELAND, OHIO

To GEORGE W. CRILE belongs the credit of first calling attention to the importance of protecting the exophthalmic goitre case from traumatic and psychic stimuli. Trauma can be largely done away with by means of local block and gentle handling of tissue. The psychic factor has been more difficult to master. We now have the answer for this phase of the problem in giving barbituric acid compounds before operation. Our aim in the generalship of these cases has been to give the least insult to the patient's organism as a whole while doing the necessary operative procedure. The barbituric acid compounds offer a real help in controlling the patient's fear during his day of operation.

Given as a draft a couple of hours before operation it makes the day, previously one of anxiety, one of drowsy indifference. There are a number of these compounds varying little in their physiological action and toxicity. Barbitol, the earliest of these, was introduced by Fischer and Von Mering in 1904.

The formula :

Barbitol



The ethyl groups can be replaced by other alkyl or phenyl radicals to form a large number of derivatives, *e.g.*, when the ethyl group is replaced by the normal butyl group we make "neonal"; when the ethyl group is replaced by the phenyl group we have phenol barbitol—luminal, etc. For this series of observations we have chosen iso-amyl ethyl barbituric acid, or amytal. It may be obtained of Eli Lilly & Co.

The use of amytal was brought to our attention in the fall of 1927 while visiting Prof. John Tait's laboratory at McGill University when one of his students, Mr. W. H. Finney, showed us dogs that had been given amytal intravenously. The animals were completely unconscious and deeply anæsthetized. We were told that this state lasted up to thirty-six hours.

\* Read before the Cleveland Academy of Medicine, February 21, 1930.



Dogs on which operations were being done gave no indication of pain. We were told that when the anæsthetic wore off the dogs came out of their stupor and returned entirely to normal as far as he was able to discover from any subsequent physical or chemical finding.

The oral use of amytal in the human immediately occurred to us, and on our return we proceeded to investigate its use and any possible harmful effect on man.

1. *Chemistry*.—Amytal, or iso-amyl ethyl barbituric acid, a crystalline powder, is ordinarily dispensed in tablets. It is insoluble in cold water, more soluble in hot, and has a brackish taste which is difficult to disguise. We have given it only by mouth or by rectum. Hot milk, hot water, or tea as suggested by Doctor Sollmann, have been the vehicles used.

Within the hour of taking the dosage we have been using, patients become drowsy and, as the action increases, fall asleep. We have found it to work equally as well when given in hot water by rectum. By the end of two hours the majority are so sleepy that they give no thought to their surroundings. The alert and introspective may voluntarily resist the sleepiness—yet are perfectly tranquil.

2. *Physiological Action*.—There is a fall in metabolism; respiration is increased in rate but has a lesser amplitude; the pulse and blood-pressure are not changed. The body temperature tends to fall. Gastro-intestinal motility is quick under amytal anæsthesia. Blood sugar is not affected. The kidney is not damaged, no pathological elements being found in the urine after its administration, although there are more urates. Bleeding and clotting time are not changed from the normal. There is no change in the  $\text{CO}_2$  combining power of the blood.

3. *Method of Administration*.—Amytal or its sodium salt has been given to man in solution by vein. We have been unwilling to inject the drug into a vein, fearing accidents. The drug is unstable in solution. Solutions have to be carefully made. They deteriorate on standing and become cloudy. A deteriorated solution given by vein causes respiratory difficulties, *e.g.*, Cheyne-Stokes breathing. If the undeteriorated solution is given too fast it may cause paralysis of the respiratory centre. When this happens in animals they do not recover (Barlow)—the heartbeat continues until death. According to Eddy the average fatal dose in cats given by mouth is 100 milligrams per kilo of body weight—50 to 60 per cent. of the fatal dose produces surgical anæsthesia. Swanson found 45 to 60 milligrams per kilo given intravenously causes surgical anæsthesia in rabbits, cats and dogs. Zerfas and McCallum report 15 to 20 milligrams per kilo in man given intravenously causes surgical anæsthesia. Man is more susceptible as only one-third to one-half the dosage in animals is necessary for surgical anæsthesia. No lethal dose is known for man.

Our object has been to find an adjuvant to nitrous oxide anæsthesia rather than to obtain surgical anæsthesia by amytal alone. We have thus stayed well within its margin of safety, both in regard to its primary toxicity and

also its morbidity. When large doses are given for basal surgical anæsthesia there is some liability to pulmonary complications due to the prolonged stupor and lack of complete pulmonary ventilation. After oral administration of amytal and morphia it takes much less than the usual amount of nitrous oxide to induce surgical anæsthesia. The patient is very comfortably robbed of the natural anxiety coupled with operation and, furthermore, is in a doze the rest of the day. There is induced in the patient at the same time a marked general analgesia as well as an amnesia.

The cases reported below are from the author's private practice. The diagnosis, operation and after-care claimed his personal attention in each instance.

We experimented with the dosage on exophthalmic goitre cases and after various trials have come to the opinion that it works best when combined with opium, as suggested in a personal letter by Dr. Irving H. Page, of the Presbyterian Hospital, New York. We prefer to give the morphine by mouth as even a hypodermic upsets these patients. The action of amytal resembles that of the general anæsthetics. The heavy and vigorous patients need proportionately larger doses in contrast to the old and feeble who are more susceptible to its action. Our youngest goitre patient was twelve years old, the oldest sixty-seven. Three vigorous men, although they did not remember going to the operating room and were tranquil before operation, went through contortions for one hour afterward. These contortions were slow and orderly, not in the least violent; as, for example, one persisted in taking the knee-chest position—a hypodermic of morphine quickly brought tranquillity. These three instances were the only unpleasant after-effects noted in the series; we have seen no stimulation before operation. Post-operatively they were, with the above exceptions, tranquil and dozy.

Our present dosage is 15 milligrams per kilo—or one grain for each ten pounds of body weight. Eighteen grains has been our largest dose given. Morphine 10-15 milligrams is added and the whole given by mouth as a draft two hours before operation. We have noted that two hours after its exhibition the maximum effect takes place. There is some variation in susceptibility in individuals of the same age and weight. Under ideal circumstances the patient is oblivious to his surroundings. Some may not fall asleep, yet have no memory of what happened. They may be wheeled to the operating room and 75 per cent. of them have no recollection of it.

Amytal makes an ideal preparation for local anæsthesia, *e.g.*, hernia; or, in addition to the amytal, one can do the operation under block and nitrous oxide analgesia.

We prefer to operate on goitre cases under light surgical anæsthesia induced by nitrous oxide and oxygen given after they have reached the height of the effect of the amytal and morphia. In this manner we are able to do away with the mental factor.

Patients may show a slight degree of cyanosis which persists several hours after their operation. Morphia tends to accentuate this.

4. *Impressions After Operation.*—Patients look on it as a boon, in that they are robbed of the anxiety attending their operation. The day of operation is a blank and they have only the kindest memories of a previously trying experience. A number have not been aware that they have been operated on and have asked the following morning when the operation would be done.

We have seen no indication that bacterial immunity is lowered in cases of infection. Patients with heightened blood-pressure do well. Three of our goitre patients have had sugar in their urine previous to operation and post-operatively for several days, then clearing up. In thyrotoxicosis the metabolic rate is reduced. The boon is that very sick patients are more susceptible than usual. In bad-risk patients it is ideal. We have used amytal with the happiest results in the cardiac arrhythmias of thyrotoxicosis. There were several of these. One had previously had three periods of broken compensation before coming to operation—stethoscope apex 138; brachial cuff 100. In another the severity of the intoxication was such that we feared to do more than a ligation. Three weeks previously this patient was delirious—he responded well to Lugol's solution and infusions of saline. His heart was fibrillating badly at the time of ligation—basal rate then plus 61. We did one side at a time under amytal and local block, with excellent results. One exophthalmic, plus 79, who had bilateral cystic kidneys—P. S. P. 30 per cent. in two hours—showed no increase, that we could detect, in kidney damage following operation. We have used it in suppurative cholecystitis in the old in conjunction with nitrous oxide analgesia and local block. The patients have had no pain or discomfort during the procedure, and lay perfectly relaxed and tranquil. In no case have we noted any kidney damage following the administration of amytal. There were four cases where the urine post-operatively showed a trace of albumin when it had been normal before operation. In each instance the specimen showed no albumin the second day after operation.

We have tested the effect of amytal and morphia on metabolism in three exophthalmic goitre patients who previously had had Lugol's solution for nine days. Allen Graham has shown, an exophthalmic goitre patient, previously not having had any iodine, reaches his lowest metabolic rate on the ninth day after starting the iodine. We therefore gave these patients iodine for nine days and then tested their metabolism again. Two days later they were given their usual dose of amytal, 15 milligrams per kilo of body weight, plus 15 milligrams of morphia; two hours before the metabolic rate was again determined. There was noticed in each instance a marked drop—plus 52 to plus 24; plus 17 to minus 26; plus 59 to plus 21—more than 50 per cent. They were taken immediately after their metabolic test to the surgery where they were operated upon. This drop in metabolism we think is a very beneficial effect of amytal in exophthalmic goitre patients. Denel, Chambers and Evergen have shown in animals that it persists for five or six hours. See Table I.

# AMYTAL IN GOITRE OPERATIONS

Under this dosage of amytal and morphia we noted a decrease in the amplitude of the respiratory excursion and an increase in the respiratory rate.

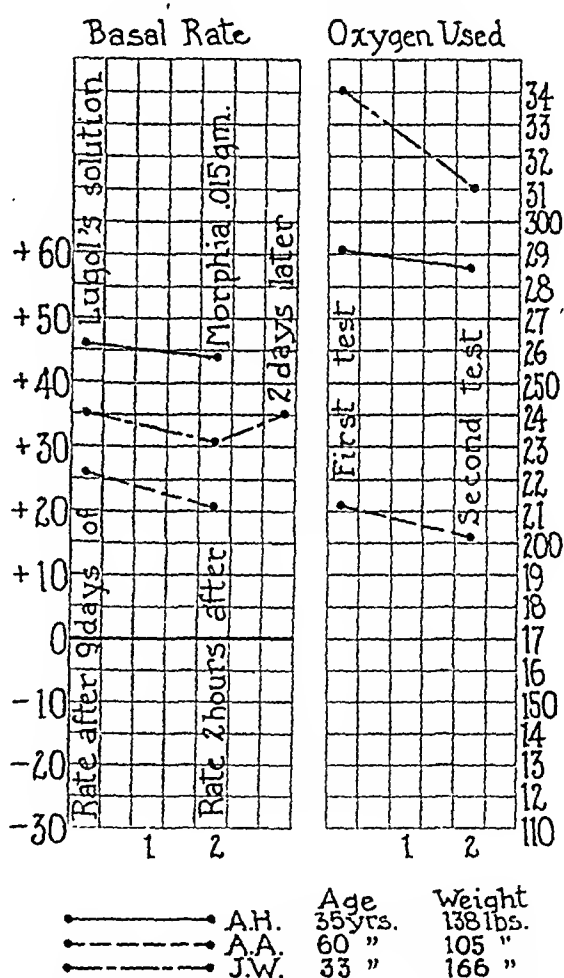
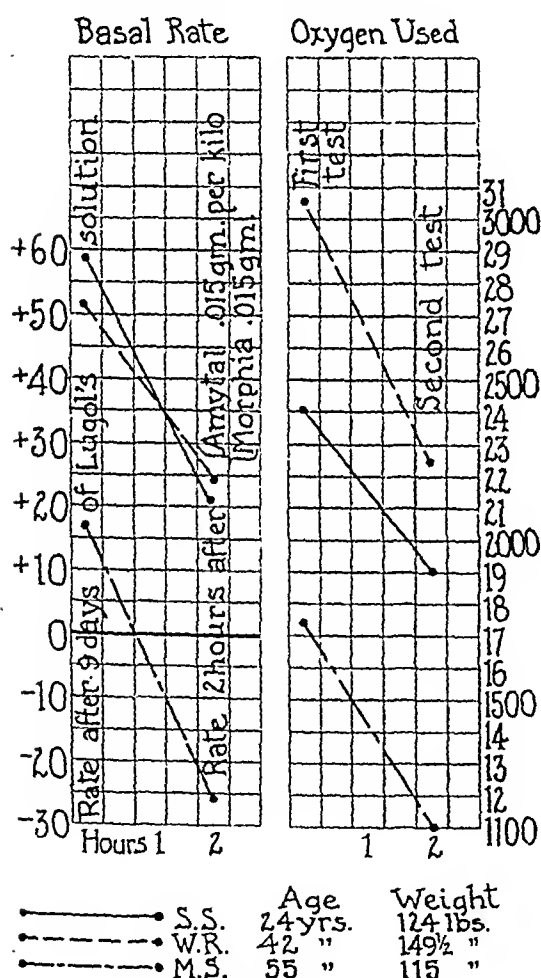
Three other cases who had likewise been iodized were tested after having been given only morphine gm. .015 by month two hours before. They also showed a drop in their metabolic rate—plus 45 to plus 41; plus 26 to plus 21; plus 35 to plus 31. We tried in this way to determine the action of amytal and morphine when compared to morphine alone when given under the same conditions. Under morphine alone we noted a slowing of the respiratory rate with an increase in the depth of the excursion.

TABLE I

## Comparative Basal Metabolic Rates (Iodized Gland)

With and Without Amytal and Morphia

With and Without Morphia



In the second case done with morphia alone, two days later metabolism was again determined without morphia and had returned to that of four days previously.

Our routine procedure in exophthalmic goitre patients is as follows:

They are told they will be operated on when their condition is favorable, and the subject is not further discussed. We have found they stand this uncertainty better than to know the time set for their operation. They are in hospital several days before operation. We plan to do the operation on the ninth or tenth day of their iodination, when their metabolic rate reaches its lowest point, if they previously have had no iodine medication. All our

thyrotoxic cases receive iodine before operation whether the anatomical lesion is a hyperplasia or adenoma. We prefer to operate early in the morning—so, on waking, they are given the draft of amytal and morphia. No preparation is made of the operative site nor is there any change of clothing. They are so drowsy at their usual breakfast time that the withholding of the meal passes unnoticed. Two hours after having the amytal they are gently wheeled in their beds to the operating room. The tactful nurse in attendance has in the meantime covered their eyes with a piece of moist gauze. Silence of the attendants is maintained and any sudden jolts to the bed in its transit, as well as extraneous noise, avoided. The anæsthetist awaits their arrival in the operating room, mask in hand, with a gentle flow of nitrous oxide running. The patient is not touched nor spoken to while the anæsthetist gradually lowers the mask into place. After a minute the mask touches the face, is clamped in position, and the patient is ready to be placed on the operating table. When the whole procedure goes through with finesse we expect to have the anæsthetized patient on the table with the same pulse rate and blood-pressure of the day before while in bed. In this manner they are operated on under surgical anæsthesia where we are able to control our asepsis. They are then put back in their bed and wheeled to their room. So the drowsy day goes on.

In several instances we have done the thyroidectomy under amytal and local block. The tranquillity of the patients was marked in its contrast to the agitation seen when only morphia and local block are used.

The nurses emphasize the tranquillity following operation in comparison with goitre patients not so managed. All drowsy effect disappears by the next morning. We have seen no stertorous respiration following operation as our dosage is not sufficient to cause deep stupor. No patient vomited more than three times after operation, and usually only once. Nausea occurred after operation in 20 per cent. of the cases. It is our feeling that this is directly dependent on the severity of the disease and the nitrous oxide added. On return to the ward we found the rectal temperature had already started to rise as is usual following operation in thyrotoxicosis. In other than thyrotoxic cases the post-operative temperature is a fraction of a degree lower just after operation and comes up to normal in one to two hours.

In reviewing an equal number of goitre operations done by the author, the sequence immediately preceding this group under the same technic in equally severe types of disease but using morphia and atropine as a pre-anæsthetic medication instead of amytal and morphia, we noted:

*Amytal and Morphia*

No. cases—60  
Diagnostic B.M.R. plus 48  
Highest rectal post-op.  $T^{\circ}$  38.86  
Highest post-op. pulse 127  
B.P. Bed day before 137/78  
B.P. Anæst. on table 142/81  
Pulse rate in bed 94  
Pulse rate on table 106

*Morphia and Atropin*

No. cases—60  
Diagnostic B.M.R. plus 42.6  
Highest rectal post-op.  $T^{\circ}$  38.76  
Highest post-op. pulse 132  
B.P. Bed day before 146/74  
B.P. Anæst. on table 162/83  
Pulse rate in bed 98  
Pulse rate on table 127

In 20 per cent. of this series we have failed to put the anæsthetized patient on the operating table with the same pulse and blood-pressure reading as the day before while they were in bed. In doing this we must bear in mind the explosive nature of the disease with which we have to deal. Also there is the factor of changing house staff and nurses as well as the varying susceptibility of patients to the drug, as well as our experimental dosage in the series. With the perfection of the method and adequate dosage we expect our next series to show marked improvement over this percentage.

The advantages of amytal in connection with thyroidectomy amount to this: We are able to remove the patient's gland more artfully, with less mental jolt, and the day of operation, formerly remembered as a nightmare, is robbed of its terror.

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TRANSPLANTATION OF THE URETERS  
FOR CANCER OF THE BLADDER WITH CYSTECTOMY  
BY ROBERT C. COFFEY, M.D.  
OF PORTLAND, OREGON

THE bladder is the last of the more important removable organs to be brought into the legitimate surgical field for the radical treatment of cancer. Beginning with carcinoma of the uterus, stomach, large intestine, rectum and lastly the bladder, the operation for removal of each of these organs has, in its turn, passed through a stage of empiricism and uncertainty as to its real value. The final standardization of surgical procedure for the treatment of cancer of each of these organs has been consummated largely by careful study of the lymphatics and blood-vessels of the organ involved.

A vital consideration which has delayed development of radical surgery of the bladder beyond that of other organs has been the lack of a satisfactory method for disposal of the ureters. Prior to the solution of this problem, the feasibility of the operation has been so questionable that there has been very little incentive to work out a technic. Nevertheless, some definite plans have been evolved for removal of the bladder, notably that of Albarran<sup>1</sup> and later the one submitted by Beer.<sup>2</sup> Both of these operators, however, have gone no farther than to bring the ureters to the surface, at the most convenient place, after the bladder has been removed. Eliminating the few hundreds of sporadic cases, more or less, which have been reported in the literature as having been performed without any very definite plan, with an operative mortality of more than 50 per cent. we may consider the recent development of the operation of cystectomy under four headings or plans as regards the disposition of the ureters:

First, systematic removal of the bladder by a definite plan in which, after removal of the bladder, the ureters are brought to the surface in some definite way. In this, Beer<sup>2</sup> seems to have been more successful than others. Secondly, a systematic plan for removal of the bladder for cancer after the ureters have been transplanted at two separate operations by the submucous technic described in 1909<sup>3</sup> and 1910.<sup>4</sup> In this plan, removal of the bladder constitutes a third major operation. Lower<sup>5</sup> apparently has tried this plan more fully than any other surgeon and has found it unsatisfactory. While I brought out this method of transplanting his ureters, I have never felt at any time that this second plan was feasible for the treatment of cancer of the bladder. For this reason, I set about to perfect a third method by which both ureters could be transplanted simultaneously. This was accomplished by using large inlying catheters, the final technic of which was described in *Surgery, Gynecology and Obstetrics*, November, 1928, under the

title: "Transplantation of the Ureters into the Large Intestine."\* Detailed report of the clinical results of this operation was recorded in the *Journal of the American Medical Association*, November 16, 1929, under the title: "Bilateral Submucous Transplantation of Ureters into Large Intestine by Tube Technic." In this series, twenty cases were reported with one operative death. Of these, transplantation had been performed for cancer in eight cases (2, 5, 6, 7, 8, 13, 14, 19), without operative death. Of the eight cases, three (2, 7, 8) had extensive metastases in other parts of the body and transplantation was done entirely as a palliative measure. Of the remaining five cases, three (6, 13, 14) had local extension to such a degree that removal was thought impossible. In these cases, the ureters were transplanted and radium in destructive doses was used. In one of these cases (6), the bladder seemed to have been destroyed and the growth locally cured by the radium, but the patient died a sudden death seventeen months after operation, seemingly from some form of thrombosis. As the patient was living in a remote mountainous district, no post-mortem could be obtained. In Case 13, the growth infiltrated the base of the bladder and extended to the deep pelvic fascia. Massive dosage of radium was used which for a time reduced the growth and slightly reduced the pain though only temporarily. Then the growth took on very active development and the patient died nine months after operation with extensive metastases in the liver as well as extension of the local growth. In the other case (14), the growth was extensively treated by radium applied directly to the growth. After the first dose, the growth seemed to diminish but it soon recurred and began to grow actively. After the second attack upon the growth by radium, no effect was noticed and four and one-half months after the transplantation operation, the bladder was destroyed with a cautery. Within six weeks, transplants, cytologically similar to the original growth, appeared all over the cavity of the wound. Patient died fifty-four days after the cauterization from the exhaustion produced by the fulminating recurrent growth. This left two operable cases (5, 19), in one of which there was a very large infiltrating growth extending down to the neck of the bladder. In both cases, extensive dosage of radium was used in the bladder after the transplantation.

In one case (5), in which the growth had returned, following microscopic examination and radium treatment a year before, the ureters were transplanted on July 3, 1928. A large dose of radium was used on August 4, 1928, and total cystectomy was done September 20, 1928, at which time the bladder showed extensive fibrosis resulting from the radium but no active cancer was found in the microscopic sections examined. The patient has remained entirely well up to the present time, twenty-two months after the ureters were transplanted.

In Case 19, 6000 milligram hours of radium were used in the open bladder directly against the growth, with the result that the growth almost disap-

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\* The previous preliminary presentation was published in *Northwest Medicine*, May, 1925.



peared, but leaving a small open ulcer which would not heal. It was thought wise to do a total cystectomy which was performed November 26, 1929. This patient had a stormy convalescence from the last operation as a result of what seemed to be a low-grade infection around the pubic arch. As the patient recovered and was ready to leave the hospital, examination through an opening in the vagina showed that the pubic bone was bare and that the

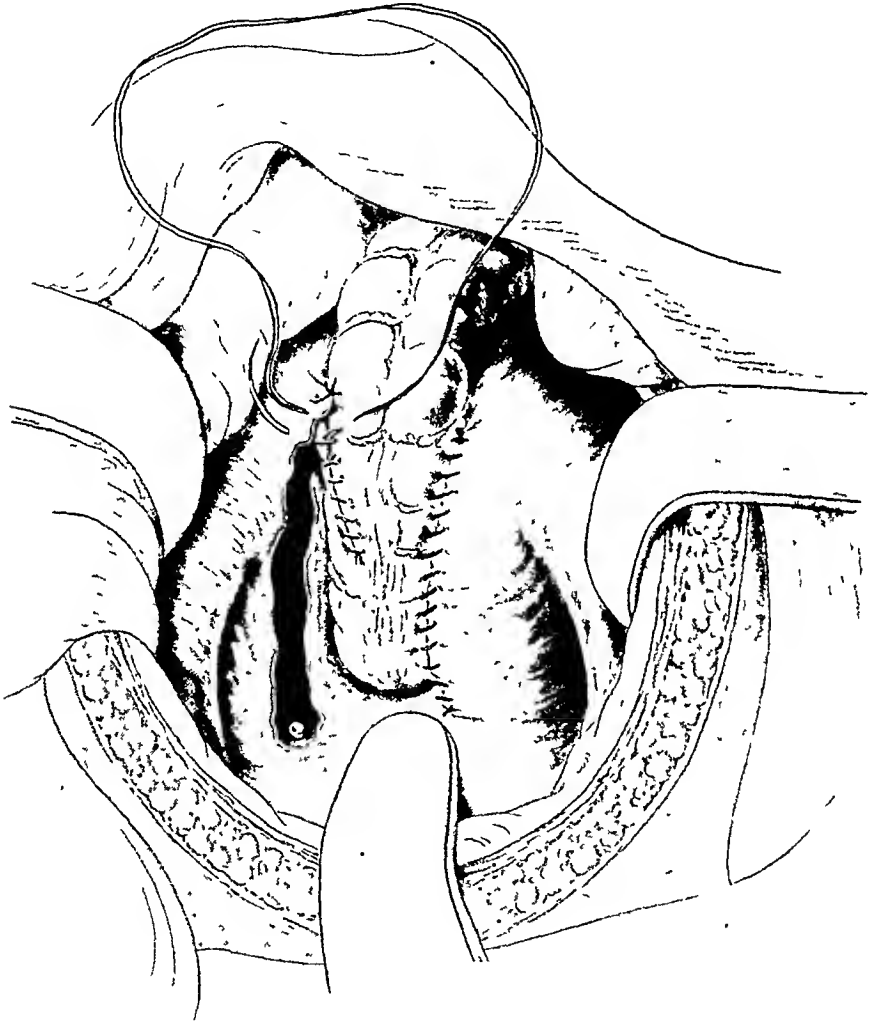


FIG 1—Ureters have been transplanted and the peritoneal edge forming the outer margin of the slit from which the ureter has been elevated, is being sewed over the ureter and the line of intestinal suture. This gives potential retroperitoneal drainage to the field of the bladder operation

cartilage of the symphysis pubis had disappeared leaving space between the ends of the pubic bones. Fortunately, fibrous ligaments at the upper and lower margins of the pubic bone had developed to such an extent that there was no mobility. Patient left the hospital with good locomotion, in good condition, and was apparently cured of the cancer. I believe the injury to the bone and cartilage was caused by the large dosage of radium.

To the report of these two cases of cystectomy for cancer preceded by

## TRANSPLANTATION OF THE URETERS

bilateral transplantation of the ureters, may be added two more cases by this method which have been reported to me in personal communications by Dr. Frank Lahey, of Boston, and Dr. W. L. Estes, Jr., Bethlehem, Pa. Both surgeons express themselves as highly satisfied with the results.

I believe that bilateral transplantation of the ureters by the tube technic, with removal of the bladder by a second operation a few weeks later, constitutes a marked advance in the radical treatment of cancer of the bladder. However, there are certain drawbacks to the two-stage plan:

1. The cancer is growing during the interval between operations.
2. The intraperitoneal drainage and convalescence from a four or five weeks' illness plus the adjustment of the renal function to the new location

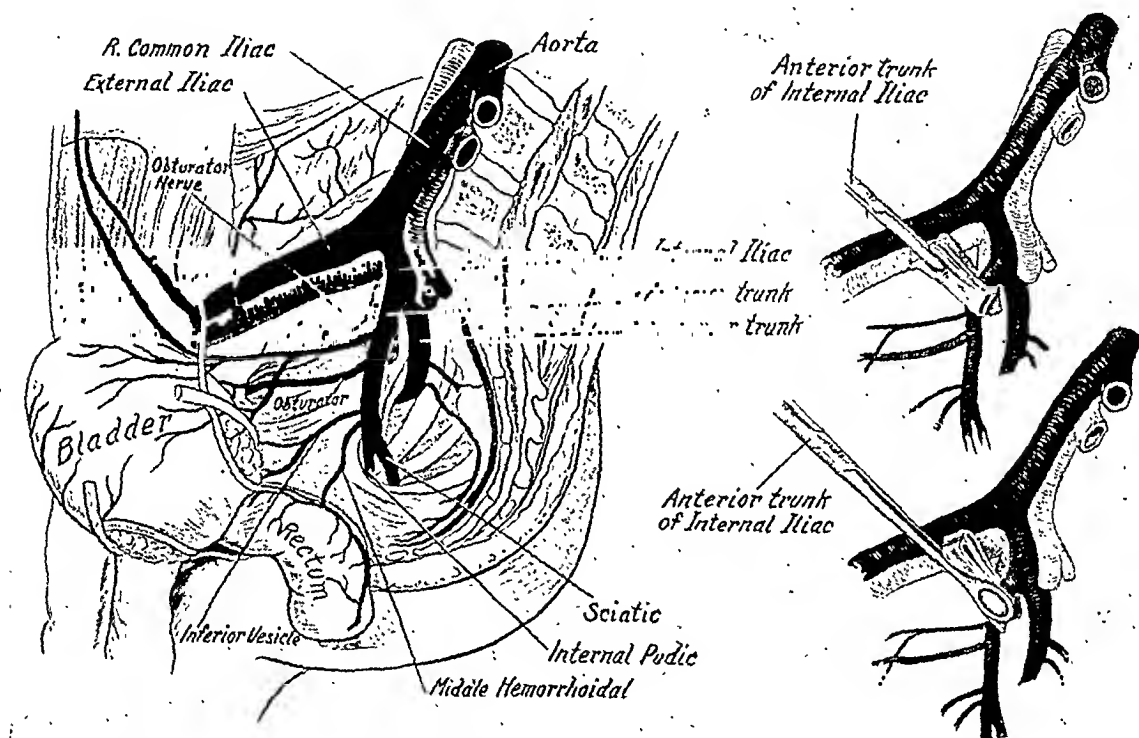


FIG. 2.—Adaptation of a figure from Gray's Anatomy to show the blood supply to the bladder. The two figures to the right show how the anterior trunks of the internal iliacs which supply practically all the direct blood supply to the bladder may be temporarily obstructed while the operation is performed.

of the ureters, is not a perfectly ideal point from which to start a cystectomy operation.

3. The wound for the cystectomy must be made through a recent operative field and such a wound is usually cramped for size, making the operation difficult.

The advantages of performing the cystectomy at the same time the ureters are transplanted are obvious:

1. The growth is obliterated at once, and its progress thereby stopped.
2. The drainage may be made entirely extraperitoneal.
3. The large wound which has been made for double transplantation of the ureters makes the operation of cystectomy much easier than when it is done through a special cystectomy wound, for besides the ease of manipulation, the blood supply may be easily located and absolutely controlled. There

is no blood lost and practically no additional shock follows as a result of the added operation.

4. There is one operation, one siege of drainage and one convalescence instead of two. The time in the hospital is less than half that of the two-stage operation.

*Steps of operation.*—A long abdominal incision is made to extend above

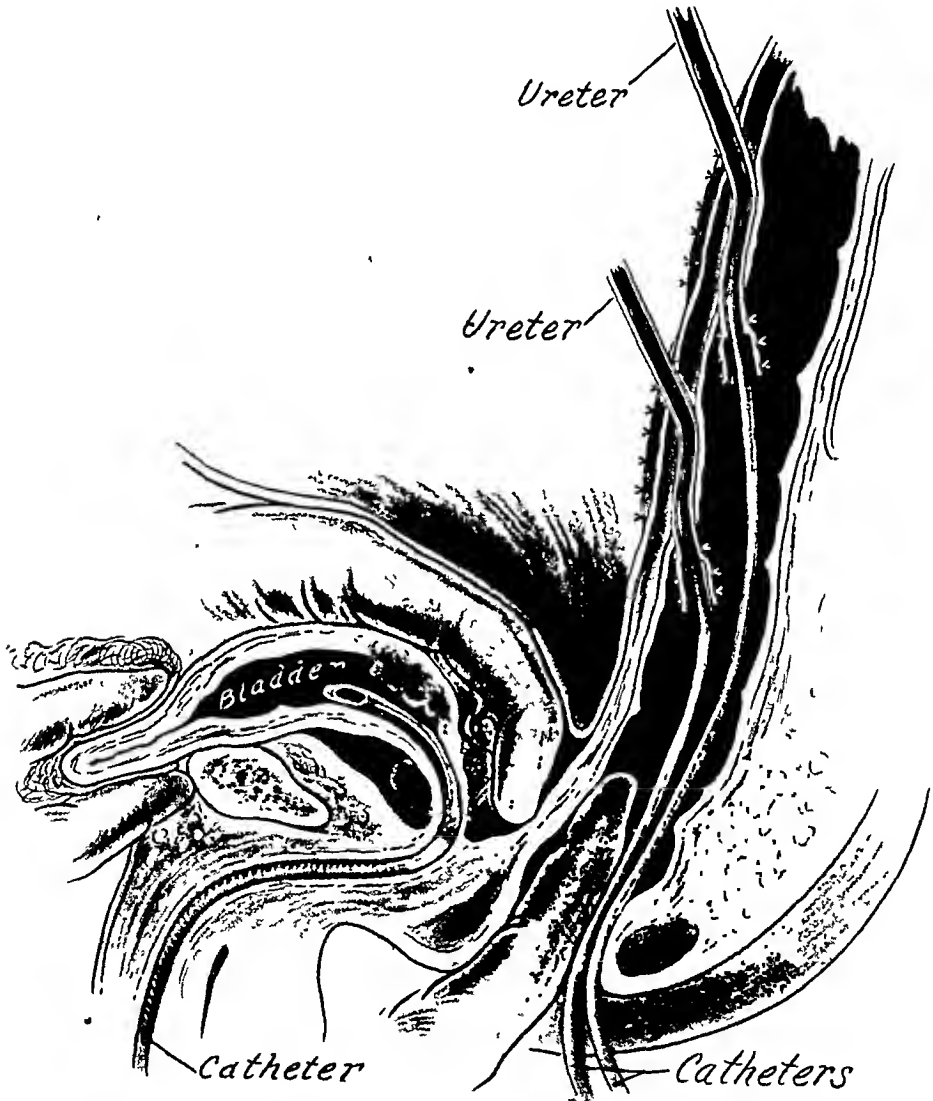


FIG. 3—Mobilization of the bladder by the fingers has just been completed, including the vesiculæ seminales and the prostate. The catheter which has been used both to drain the bladder and inject it with alcohol is still in place. An assistant's finger is in the rectum as a guide.

and slightly to the left of the umbilicus. The kidneys are carefully palpated to determine their physical condition with particular reference to hydronephrosis. The transplantation operation is performed by the exact technic described in *Surgery, Gynecology and Obstetrics*, November, 1928, including the preliminary cleansing and the drying of the large bowel with gauze packing. After the transplantation wounds in the intestine have been closed,

## TRANSPLANTATION OF THE URETERS

the edge of the cut pelvic peritoneum forming the outer margin of the slit through which the ureter has been lifted is drawn over and sutured to the intestine so as to form an extra covering for the line of sutures which bury the ureters and thereby make the wound in the intestine extraperitoneal. But, instead of leaving the line of suture incomplete as a drainage opening at the lower end of the peritoneal slit which leads into the retroperitoneal space, the peritoneal wound is entirely closed (Fig. 1). This retroperitoneal space on each side of the pelvic colon connects with the space from which the bladder has been removed, giving ample retroperitoneal drainage. This obviates the necessity of passing drainage material through the peritoneal

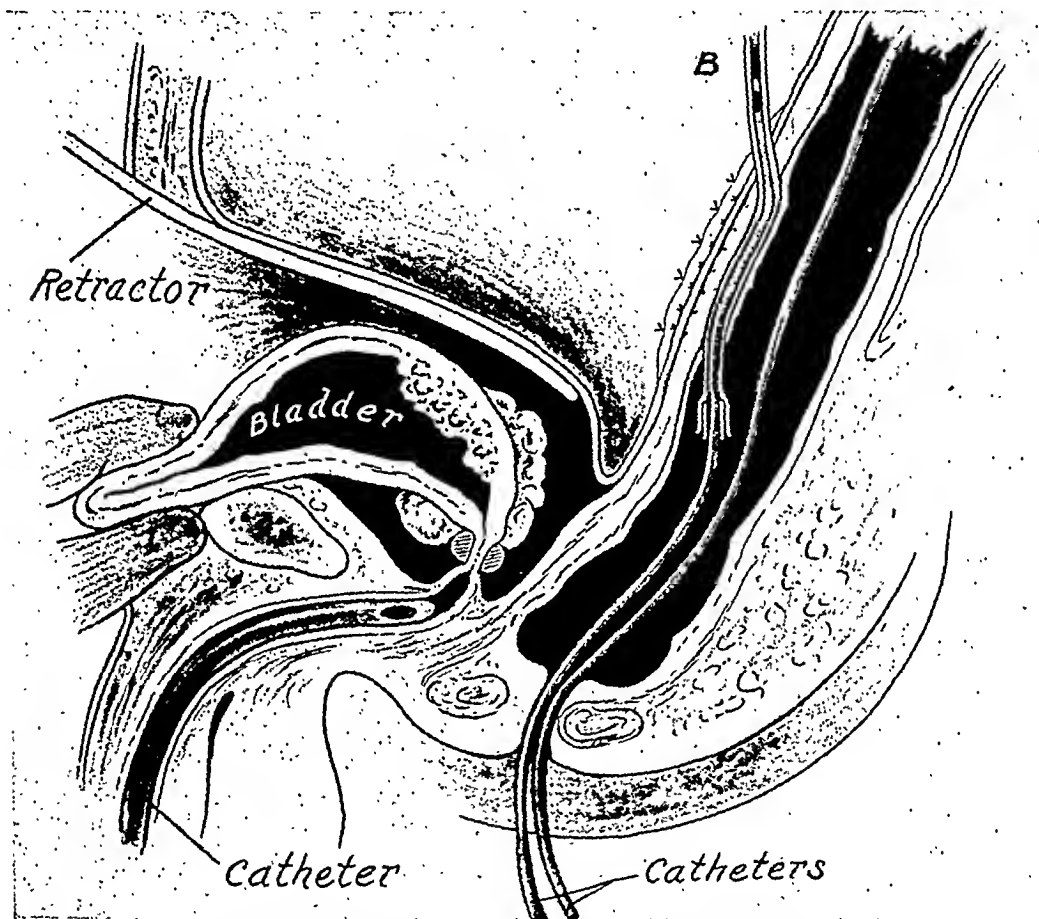


FIG. 4.—The catheter has been slipped outward while an angle forceps clamps the prostatic urethra. In a moment the urethra will be cut just below the clamp, and the bladder removed intact with its neck closed.

cavity. As soon as the intraperitoneal suturing is completed, the deep pelvis is temporarily packed with sterile gauze to prevent contamination during the cystectomy operation which is to follow. A large size catheter is inserted into the bladder through the urethra to drain off any fluid that may be in it. As a precaution against possible cancer transplant in case the bladder is opened, inject the bladder full of alcohol and clamp the catheter and leave the alcohol until actually ready to mobilize the bladder. With the fingers inserted beneath the parietal peritoneum at the lower end of the central incision, the peritoneum is separated from the abdominal wall until the iliac vessels come into view. The anterior trunks of the internal iliac arteries, which furnish practically all the direct blood supply to the bladder, are easily

located and obstructed. This obstruction may be either temporary or permanent. Temporary obstruction may be produced by passing a broad rubber band around the trunk of the anterior internal iliac. An ordinary loop sponge holder placed on the artery outside the rubber completely obstructs the direct blood supply to the bladder (Fig. 2).

Manipulations for removing the bladder are now begun by separating the bladder muscle from its peritoneum. This is easy except at the very top of the bladder where it may be necessary to separate the structures with scissors, although this is not usually the case. The fingers then separate the

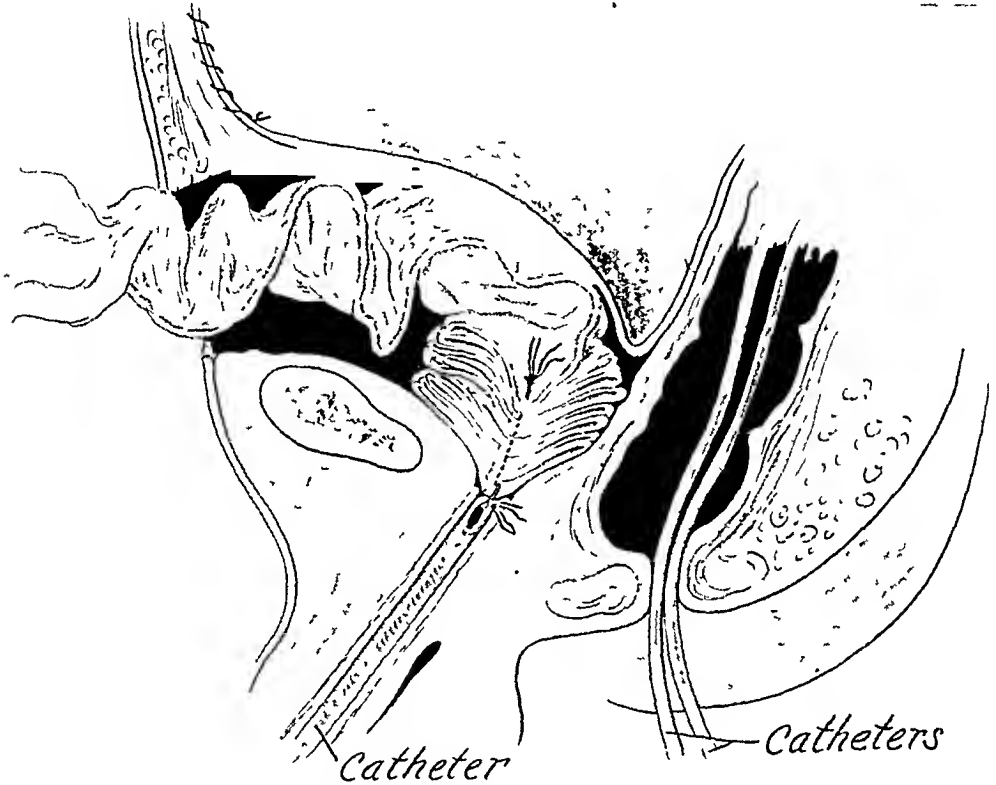


FIG 5—The catheter has been passed into the bladder space and attached to the lower fold of a specially prepared gauze pack. An assistant has pulled on the catheter from below until the gauze pack is wedged tightly in the space from which the prostate and vesiculæ seminales have been removed. The vesical space is being lightly packed with gauze. The peritoneum as it follows the abdominal wall has been closed leaving the gauze in the extraperitoneal or vesical space

bladder from the pelvic wall, bringing up some of the extra-vesical fat with the bladder. Little cords appear in the fat. These are the vessels which supply the bladder. They are clamped and cut, and separation proceeds without loss of blood. About this time, the alcohol is allowed to escape from the bladder through the catheter. An assistant, with a piece of gauze in the fingers, now picks up the fundus of the bladder and draws it forward and downward. The vasa deferentia come into view and are ligated and severed. The ureters have already been ligated and severed and their stumps are hanging to the base of the bladder. An unclean assistant is then asked to insert one or two gloved fingers into the rectum as a guide to the operator while he mobilizes the vesiculæ seminales and prostate (Fig. 3). The lateral

ligaments of the bladder are clamped and cut on the bladder side. The vesiculæ seminales are easily separated from the rectum with the fingers and soon come into view. The bladder is now separated from the pubic bone by clamping and cutting the pubo-vesical ligaments. Upon lifting up the prostate there is a certain amount of passive bleeding from the prostatic plexus notwithstanding the obstruction of the anterior iliac arteries. This bleeding may be controlled by packing a little gauze into the space while the operation continues. It is possible, and may in some cases be advisable, to transfix the prostate and ligate it after the plan of Watson and Cunningham<sup>6</sup> or Beer<sup>2</sup>. It is just as easy and probably better, however, to remove the prostate with

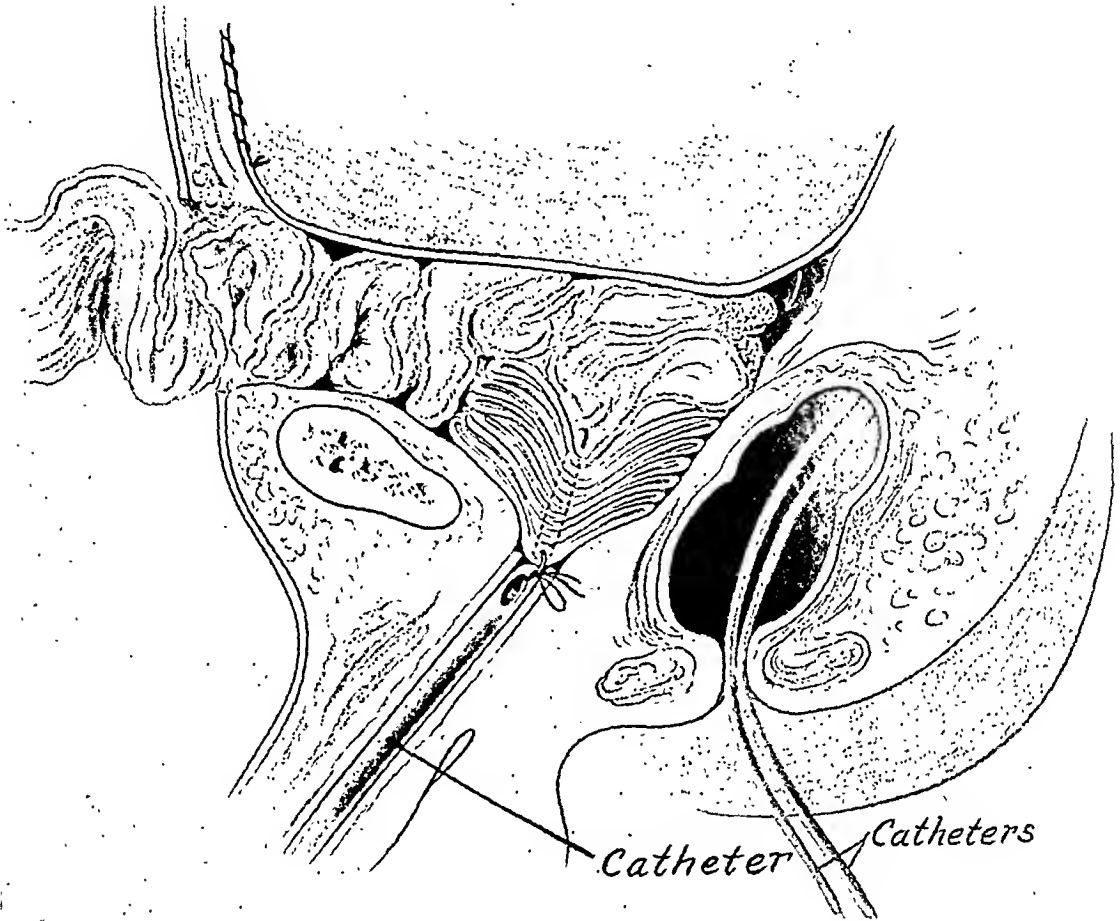


FIG. 6.—The arrow indicates drainage which might conceivably come down in the retroperitoneal space from the site of the operation.

the bladder. As soon as the prostate and bladder are completely mobilized and hang by the urethra as a pedicle (Fig. 3), the catheter within the bladder is withdrawn so that its tip is back in the urethra. An angle clamp is placed across the lower end of the prostatic urethra (Fig. 4). The urethra is severed just below the clamp, the bladder is removed, the catheter is pushed in and attached to a previously prepared gauze pack\* by fastening together the

\* A gauze strip, twelve inches wide and ten feet long, is folded to four thicknesses, edges inside. This makes a ten-foot tape. Beginning at one end, this tape is folded back and forth like the folds of a fan until 8 or 10 double folds have been made into a pack. From the proximal side a heavy quilt suture is passed through the pack and back, and then tied firmly, leaving the ends at the knot an inch long (Figs. 5 and 6).

distal fold of the pack and the end of the catheter with a strong suture. An assistant then draws on the urethral catheter from below and draws the pack into the bed from which the prostate and vesicles have been removed (Fig. 5). This completely controls the passive hæmorrhage. The thighs are then brought together by a wide band of adhesive plaster which is placed around them. To this band, the end of the catheter is fastened under tension so as to hold the pack in place until all danger of bleeding has passed. The vesical



FIG 7 —Right ureter enormously dilated as result of passing through the growth.

space is then lightly packed with the remainder of the gauze strip. The obstruction may now be removed from the anterior trunks of the iliac arteries. The retroperitoneal space on either side of the rectum communicates with the vesical space and therefore is amply drained (Fig. 6). It is interesting to observe that after the bladder is removed, the obturator nerve is lying exposed and if irritated by packing makes pain on the inside of the thighs where the nerve supplies the adductor muscles. The abdomen is closed and the operation is complete.

It has taken little more than fifteen minutes' extra time to do this complete bloodless and shockless cystectomy and we have the great advantage of having the growth out, the drainage entirely extraperitoneal and no more operation to be done.

The tension may be taken off the urethral catheter in twenty-four hours or so. The gauze may remain a week without trouble and is then removed under light gas anæsthesia. The gauze strip may be withdrawn until the proximal side of the pack approaches the opening. The external superfluous end of the catheter having been cut off, the remainder follows the gauze. The knot of the quilt suture is now cut and the pack unfolds as the strip is withdrawn (Fig. 7).

I have had the opportunity to do one operation by this technic. A brief report of the case follows:

**CASE REPORT.**—C. E. R., male, poultry farmer, age fifty-nine. He had a history of having had blood in his urine off and on for about three years. On December 12, 1929, he began to have severe pain in the right kidney region. This

persisted until the latter part of January when he began passing clots of blood. This bleeding continued. A diagnosis of cancer of the right side of the bladder had been made by a urologist. He entered our clinic March 12, 1930, and the diagnosis of cancer was confirmed. As he was having a great deal of bleeding and a great deal of pain, he was advised to have it operated upon with the understanding that he would probably have his bladder removed and the ureters transplanted into the rectum. He went home to arrange his affairs. During these few days at home he had an alarming hæmorrhage from the bladder. A doctor was called to give him relief. At the time he first consulted us, he had a hæmoglobin of 96; blood-pressure 170/100; urine showed blood and pus but otherwise was normal. He returned and entered the hospital March 20, 1930, with a hæmoglobin of 66. A blood transfusion was given. On the 22nd, his hæmoglobin was 78. He was operated upon March 22, 1930, at which time the operation described above was performed. At that time it was observed that there was a cancer of the bladder  $1\frac{1}{2}$  inches in diameter involving the right ureteral opening which also infiltrated the bladder wall. The right ureter was dilated to the size of the index finger (Fig. 7). The pelvis of the right kidney was correspondingly dilated

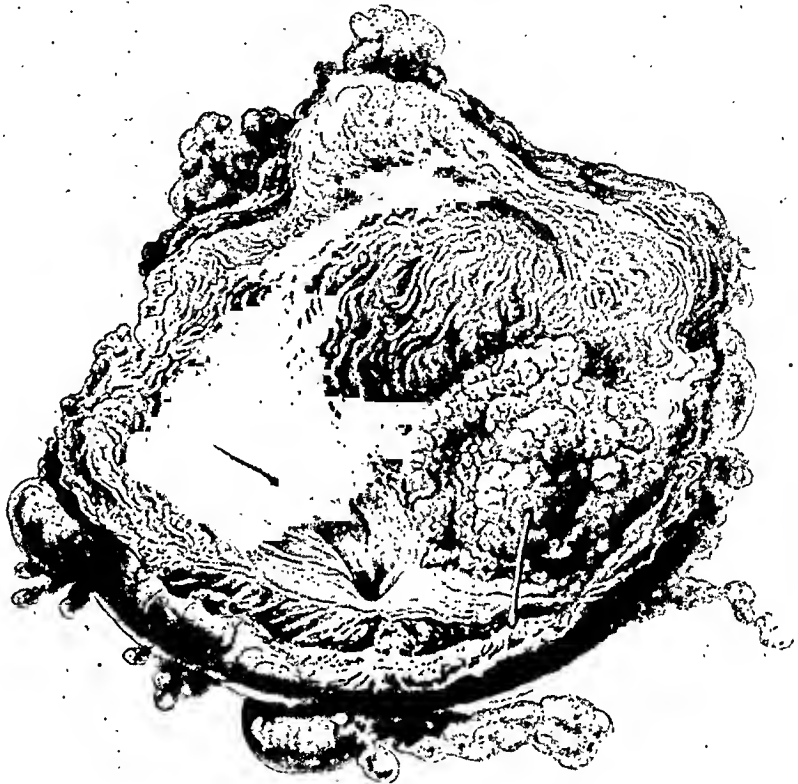


FIG. 8.—Bladder specimen laid open through posterior wall showing the growth involving the right ureteral opening.



and hydronephrotic. The left ureter was thickened but only slightly dilated. The left kidney appeared to be normal. While the patient was not greatly shocked, his hæmoglobin was low and it was decided to give him another blood transfusion at the close of the operation. He left the operating room with a pulse of 76, full and of good quality.

*Progress.*—The temperature the day before operation was  $102^{\circ}$  and remained so until two days after the operation. After this, the temperature during convalescence ranged from normal in the morning to  $99^{\circ}$  and  $100^{\circ}$  in the afternoon. During four days the temperature went as high as  $101^{\circ}$  in the afternoon and the pulse was over 100 on five separate days during the convalescence. At no time did the patient present the appearance of being seriously ill. The total output of the left kidney during the first thirteen days was 16,985 cubic centimetres, while the output from the right

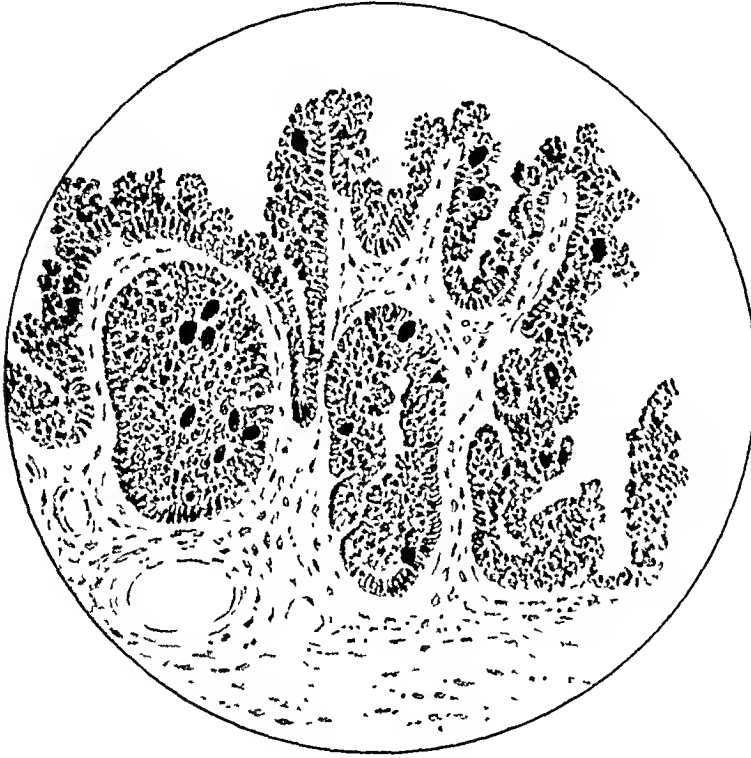


FIG. 9.—Microscopic section of growth.

hydronephrotic kidney with a dilated ureter, was 3,467. By the phenolphthalein test, the dye occurred in the left kidney in six minutes and in the right kidney in twenty minutes. This delay in the right kidney, however, may have been due to the larger capacity and the less secretion of the right kidney which required a longer time to reach the end of the catheter from the kidney pelvis. The function in this dilated kidney is in accordance with our former observation in cases where the ureter has been enormously dilated at the time of operation. In all such cases, the kidney is correspondingly damaged and apparently never entirely recovers. During the thirteen days that the catheter remained in so that comparison could be noted, there was no change in the relative output of the two kidneys. At the end of eight days, the gauze pack was removed from the bladder space and was lightly repacked with sterile gauze. A week later the packing was again changed without anæsthetic, wound held open by retractor, lighted with Cameron lights and wound inspected inside. This was done again in six days, at which time the wound was washed out very carefully and a beautiful granulating cavity was exposed and inspected. This has gradually closed. There was never at any time the slightest pain or discomfort in the region of either kidney. Patient's appetite has been fairly good and it may be said the patient made an uneventful recovery, has gone home and is seemingly entirely well.

#### CONCLUSIONS

- I. If a satisfactory reservoir for urine can be safely established and a safe removal operation can be performed, cystectomy becomes the ideal treatment for cancer of the bladder.

2. Cystectomy, no matter how safe nor how curative in its results, which provides no satisfactory reservoir for the urine, is at best a disagreeable makeshift and will never become a popular operation.

3. The fundamental necessity in performing cystectomy is that a muscular reservoir controlled with a sphincter must be provided.

4. The physical problem to be solved in performing this feat is the delivery of the output of a secreting organ in which the pressure is low and regular into a muscular reservoir where the pressure is high and irregular. In physics this can be accomplished only by the use of the valve principle.

5. In the animal mechanism, nature has invariably produced a valve for such purpose by running the delivery duct of the organ between the mucous

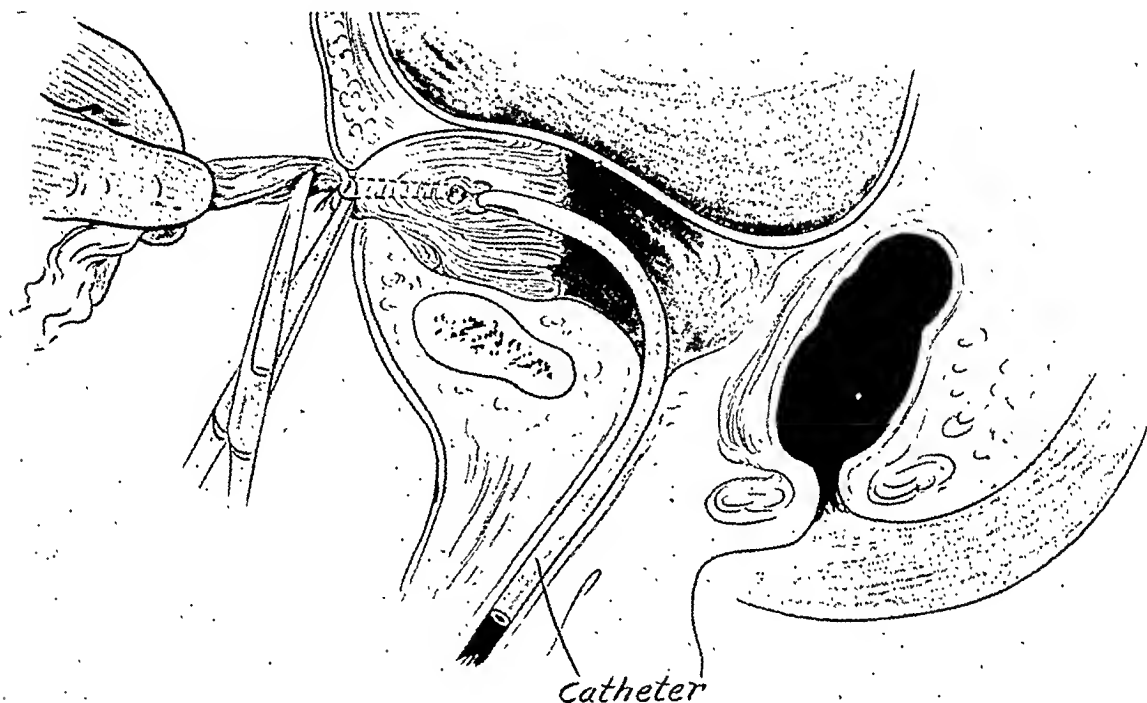


FIG. 10.—Gauze pack is pulled up into the wound and knot is being cut to permit its unfolding.

and muscular coats of the reservoir for a distance before emptying the duct. Surgical transplantation of the ureter involves this principle.

6. Three plans for submucous transplantation of the ureters have been developed (Fig. 10).

*Plan A.*—Split end of the ureter is dragged through a stab wound in the mucous membrane at the lower end of a long incision which severs all the tissues down to the mucosa. The end of the ureter is anchored inside the intestine and the ureter above the opening is buried between the mucosa and muscularis with sutures. This plan includes the fundamental valve principle. Clinical results have proven conclusively that in those patients who survive the operation, the valve thus formed is ample to protect the kidney against intra-intestinal pressure and infection from the bowel. The drawbacks to this plan are: 1. The open end of the ureter is exposed in the bowel.

2. Opening the mucous membrane of the bowel exposes the wound in the intestinal wall to immediate infection, which often produces a profound reaction during convalescence and sometimes results in death. The resultant swelling temporarily obstructs the ureter and makes bilateral transplantation inadvisable. The obvious necessity of three dangerous operations, one for

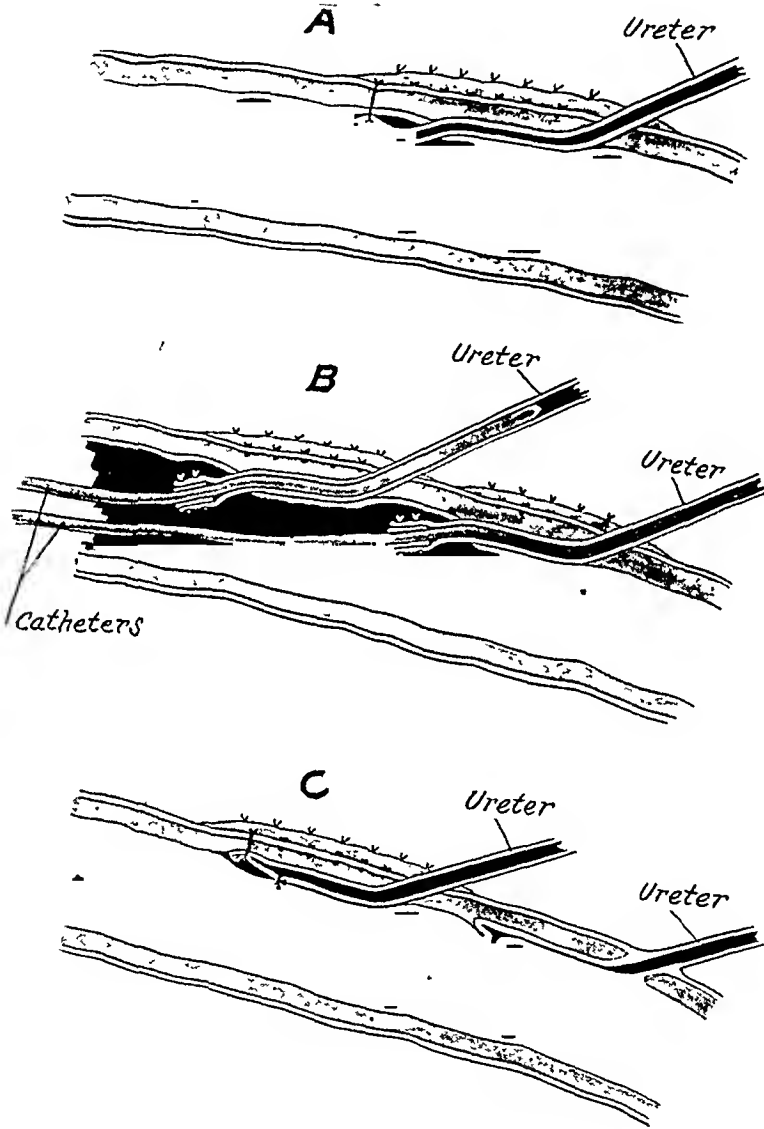


FIG. 11.—Three plans for submucous transplantation of the ureters

each ureter and one for the cystectomy, automatically eliminates Plan A from the operation of cystectomy for cancer of the bladder.

*Plan B.*—Bilateral transplantation of the ureters by the tube technic. This plan is far more complete and offers decided advantages. Great care and rigid technic for cleansing and drying the bowel is exercised in order to cut down the chance of contamination of the intestinal wound during the operation. A large catheter is placed in each ureter and the ureter is firmly

tied around the catheter where it is anchored to a soft rubber cuff. By keeping the ends of the catheters in bichloride of mercury solution, there is no possible way in which infection may ascend directly in the lumen of the ureter until the ends of the ureters slough and the catheters come away, which is usually from ten to twenty days. Renal function is in no way disturbed by this operation. Both kidneys function normally throughout convalescence. An enormously dilated ureter may be transplanted by this technic. In spite of extraordinary precautions in cleansing the bowel, there must be a certain amount of infection in the implantation wound of the bowel wall in any operative technic which opens the intestinal mucosa.

That the infection is less by Plan B than Plan A, is shown by the fact that it is far safer and convalescence is much less stormy with the transplantation of two ureters than follows the transplantation of a single ureter by Plan A.

A drawback which applies to the general adoption of Plan B as well as Plan A, is that the operation is far more serious in the dog than in the human being, probably due to the greater virulence of the intestinal bacteria in the dog. Therefore, the surgeon is handicapped in perfecting a technic by animal experimentation. Many surgeons, who would otherwise be interested in the operation are discouraged by the animal experimentation. The overwhelming concrete advantage of Plan B is that by using this plan it is possible and practical to do the complete operation of cystectomy at one sitting without drainage through the peritoneal cavity.

*Plan C.*—(Fig. 11.) Four years ago while conducting a series of animal experiments for the purpose of perfecting the tube technic, the observation was made that when one of the sutures which anchors the ureter in the intestinal wall transfixes the ureter and also the mucous membrane, a permanent uretero-intestinal fistula resulted. Later the query arose "How much time is required for the transfixion suture to cut through and make an anastomosis?" This was answered by a few experiments which showed that the urine appears in the intestine within twenty-four to forty-eight hours after the transfixion suture is placed. With this information, a technic for uretero-enteric anastomosis without immediately opening the intestinal lumen was developed.

Of seven single ureters experimentally transplanted in this way, there has been no evidence of kidney infection. The clinical recovery of the animals is incomparably better than by any previous method. The urine appeared in the intestine from twenty-four to forty-eight hours invariably, except in one case in which the transfixion suture was not tied very tightly. In this case the appearance of the urine was only sixty hours after transplantation. In cases where post-mortems have been done, there has been no peritonitis. At the end of a week, whereas by all former methods there was manifest infection in all intestinal wounds, in these cases there was no evidence of infection. The ureter was not dilated and there was no evidence of pus in the kidney pelvis. There was, however, some congestion of the

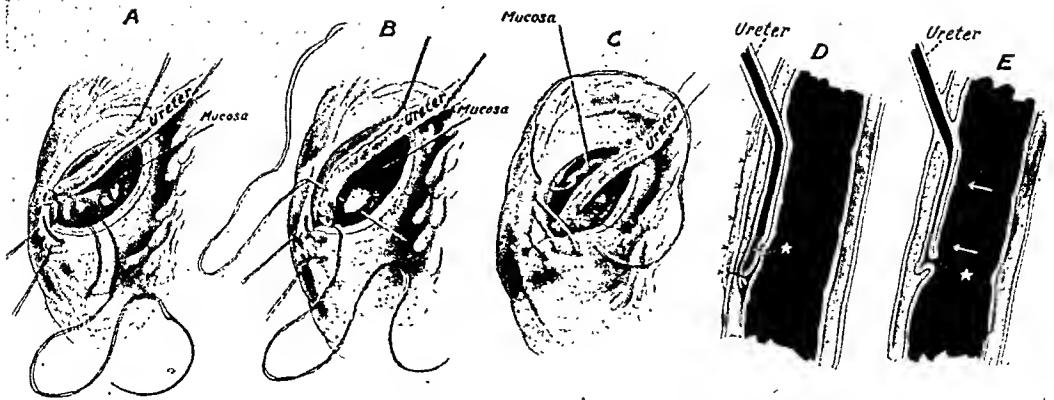


FIG. 12.—Transfixion suture technique for making a uretero-enteric anastomosis. A—End of ureter has been transfixed and ligated with 00 chromic catgut suture, doubled. Needle has passed from within out on one side and from without in on the other side and the end of the ureter is tied into the lower angle of the wound between the mucosa and muscularis. B—The end of the ureter is anchored in the angle of the wound with a catgut suture. A fine needle carrying strong fine linen or silk thread, doubled, transfixes the ureter about its middle and picks up the full thickness of a quarter inch fold of mucous membrane of the intestine. C—The muscular and peritoneal wall of the intestine is being drawn over the transfixed ureter. Interrupted fine linen sutures add additional safety. D—Sectional view of transfixion operation. Star shows transfixion suture. E—Final results of anastomosis by the transfixion method. Star indicates opening.

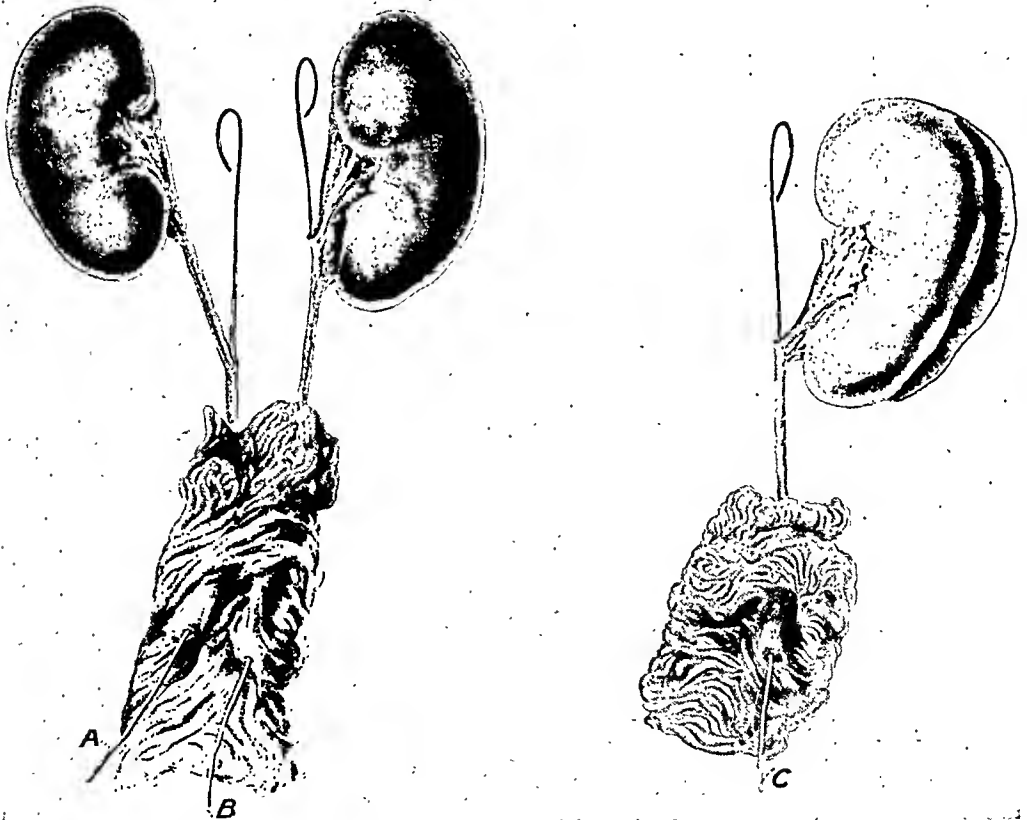


FIG. 13.—Post-mortem specimens: A—One week old anastomosis showing result of transfixion suture anastomosis of right ureter of dog. B—Four weeks old anastomosis in same dog, left ureter. C—One week old anastomosis in another dog, left ureter. Note the clean-cut opening which has been made in each instance by the transfixion suture and freedom from sloughing or other evidence of infection.

capsule of the kidney, probably due to temporary obstruction as shown by the fact that in cases where the post-mortem was done four weeks after transplantation, the vascularity in the capsule had returned to normal.

While it is impossible to state what the final outcome of this plan will be until time has demonstrated late results, it is not too early to state that these results constitute by far the most thrilling experience I have had with this work. The problem of infection of the intestinal wound which has been the bane of all other plans seems to be entirely solved by this plan. It would seem that the infection which naturally follows the suture through the intestinal mucosa is entirely surrounded and made local by normal protective forces before it involves the remainder of the wound. If the late results of this plan prove to be in accordance with the early results, it will take a very important place in this discussion. In the first place, it will completely supplant Plan A in all cases. It must be remembered, however, that this plan, as with Plan A, cannot be used in transplanting both ureters at the same time. All three dogs on whom the bilateral transplantations were used by this technic died within forty-eight hours, notwithstanding that in one of the cases the urine appeared in the rectum in twenty-four hours. Therefore, this plan cannot be safely used in the operation of cystectomy which is to be performed in one stage. It cannot be used safely even in a two-stage operation if one ureter is dilated and the kidney correspondingly damaged, lest the damaged kidney might fail to function while the normal kidney is laid up for repairs. Plan C might conceivably be used as the one of choice if both ureters and both kidneys were entirely normal. Such a plan as the following might be practical: At the first operation, let us say, we transplant the right ureter. After the urine is being delivered freely into the intestine and the kidney has apparently recovered, make a low incision through the left rectus, transplant the left ureter by the transfixion technic, (which operation requires at most only fifteen minutes for its performance and does not open the bowel) and while this wound is open, remove the bladder according to the technic which has been described. This plan is not recommended until further experimental work has been done.

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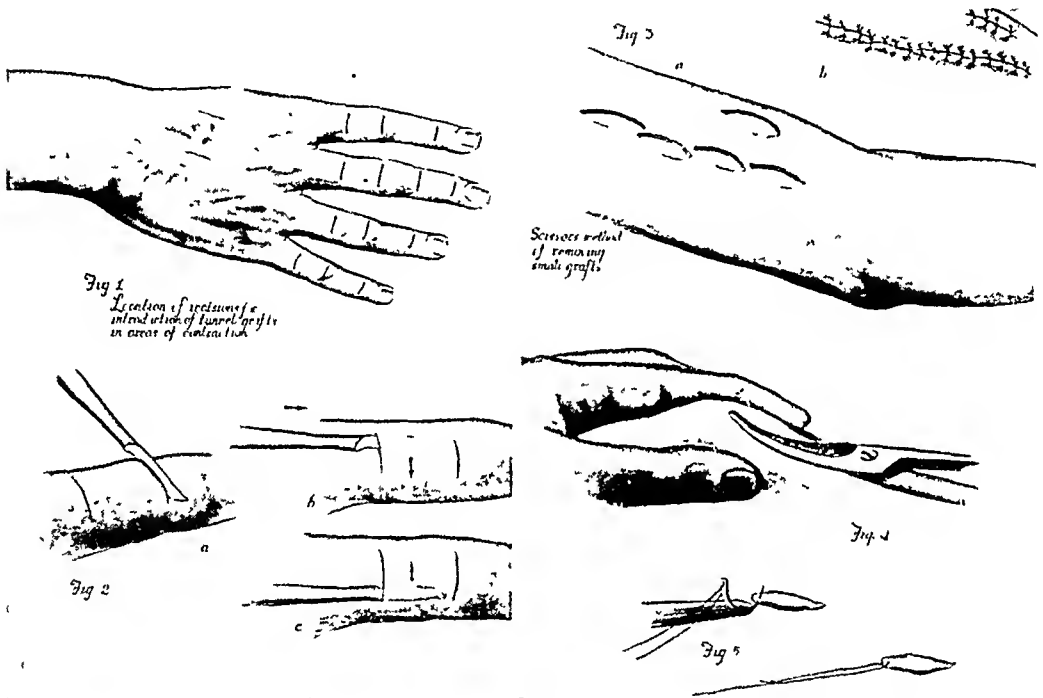
# TEN YEARS OF THE TUNNEL SKIN GRAFT \*

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THE tunnel method of skin grafting has been in use for the past ten years on the Surgical Service of the Walter Reed General Hospital. It was first described in 1922<sup>1</sup> by my assistant, the late Major A. D. Parce, Medical Corps. During the succeeding years there has been ample opportunity to study the terminal results and, based on these results, the field of usefulness



of this type of skin graft has been materially extended and the technic simplified.

The first patient on whom this method was employed was a soldier, a veteran of Chateau Thierry, who had several healed scars on the anterior surface of his leg and a large posterior scar measuring twelve inches long and two inches wide. This extended from above the popliteal space downward nearly to the point of insertion of the tendo achillis. The scars resulted from operative incisions for the treatment of osteomyelitis and gas gangrene following a gunshot wound of the leg. The posterior scar prevented complete extension of the leg and seriously interfered with the blood supply of the tissues. In addition there was a large indolent ulcer more than two inches in its greatest diameter in the centre of the scar harboring staphylo-

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coccus aureus. Numerous attempts had been made to sterilize and heal this ulcer without avail.

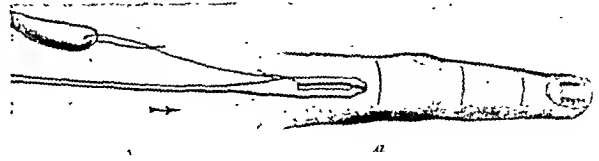
To quote Major Parce, who described this case in his article:

On August 6, 1920, under gas-oxygen anæsthesia, several rectangular grafts were removed from the thigh of the same leg with a safety razor blade, turned inside out over dental composition and sutured. A longitudinal incision was made on either side of the scar, the intervening tissue tunneled beneath and the first graft inserted on the freshly cut area beneath the tunnel. Another tunnel was made below the granulation tissue of the ulcer and a second graft placed therein. . . . The first step was done with a view of lengthening the contracted scar tissue and relieving tension on the ulcerated area, thereby improving its nutrition. The second step was made with the hope that the overlying granulation would hold the graft firmly in place until the epithelization could take place beneath, all previous grafts on the unsterile surface of the ulcer had sloughed completely in two or three days. The whole procedure was done with the idea of allowing the rigid scar tissue to stretch further.

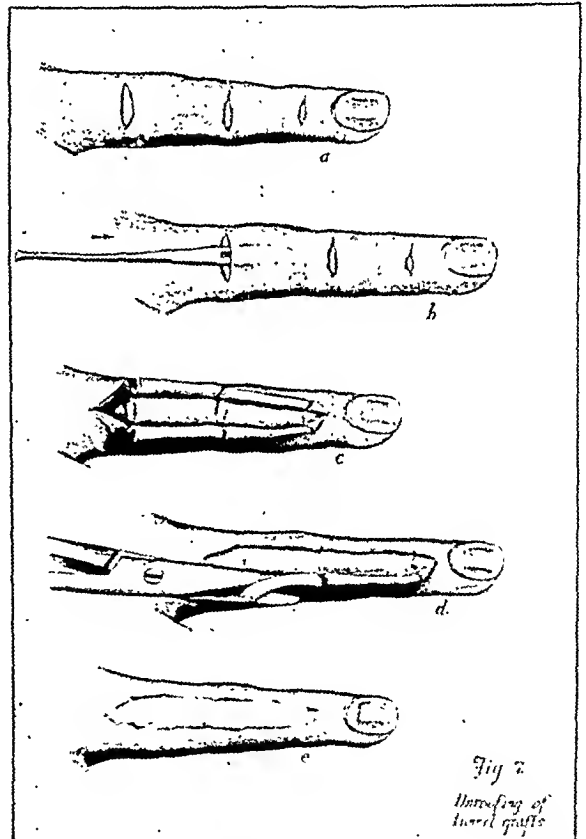
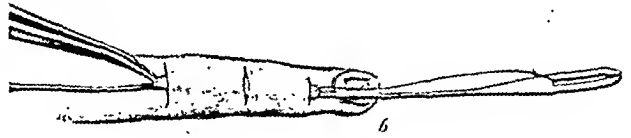
On August 14, 1920, nine days after operation, the roof of the tunnel above the dental composition was cut, and the dental composition removed, revealing epithelization of the floor without any sloughing of the graft. . . .

This case was included by Major Parce with other cases, illustrating an improved method of skin grafting based on the principles underlying the Esser inlay graft, but the only thing common to this method and the tunnel skin graft was the fact that the skin to be grafted was "turned inside out over dental composition and sutured." The principle of the tunnel skin graft is entirely different from Esser's, as by the former method the transplanted graft is buried completely within the tunnel and surrounded by tissue above and below, the dental composition being used only as a convenient obturator to aid in insertion and to maintain pressure. The use of the dental compound was later discontinued as being unnecessary.

The tunnel method should not be confused either with the "niche" graft of Alglave, used by him in granulating tissue, and which is actually a modi-



*Fig. 6.  
Method of introducing grafts beneath scar tissue*



*Fig. 7.  
Inserting of  
tunnel grafts*



fied Reverdin graft; or the Westhues graft, which is a modification of the Thiersch graft, whereby narrow strips of skin to be grafted are woven in and out through the granulating surface.

The skin used in the tunnel method is a true, thick graft, inasmuch as it contains all layers of skin and is a free mass of tissue wholly deriving its nourishment from the tissue in which it is placed, and because of the fact that in some instances the tunnel graft is tubulated, it should not be confused with tubed or pedicle grafts, which are really not grafts at all.

The tunnel skin graft has been used successfully in nearly every variety



FIG. 8—Full thickness graft under granulating ulcer tunnel.

of chronic ulcer in practically every location on the body surface. It has been especially useful in case of ulcers located in areas of limited nutrition, as in the centre of old scars. It has also been used to break the continuity in scar tissue contractures following burns in the anterior and posterior axillary folds, on the posterior surface of the thigh and leg and elsewhere. When used in large granulating surfaces following recent burns where scar tissue contraction is to be expected, a graft or a series of grafts, if placed at right angles to the line of expected contraction well under the granulating surface, before any contraction has actually taken place, will break the continuity of the fibrosis and prevent contraction. The change of position of the transplanted graft has had no apparent effect on the take or upon

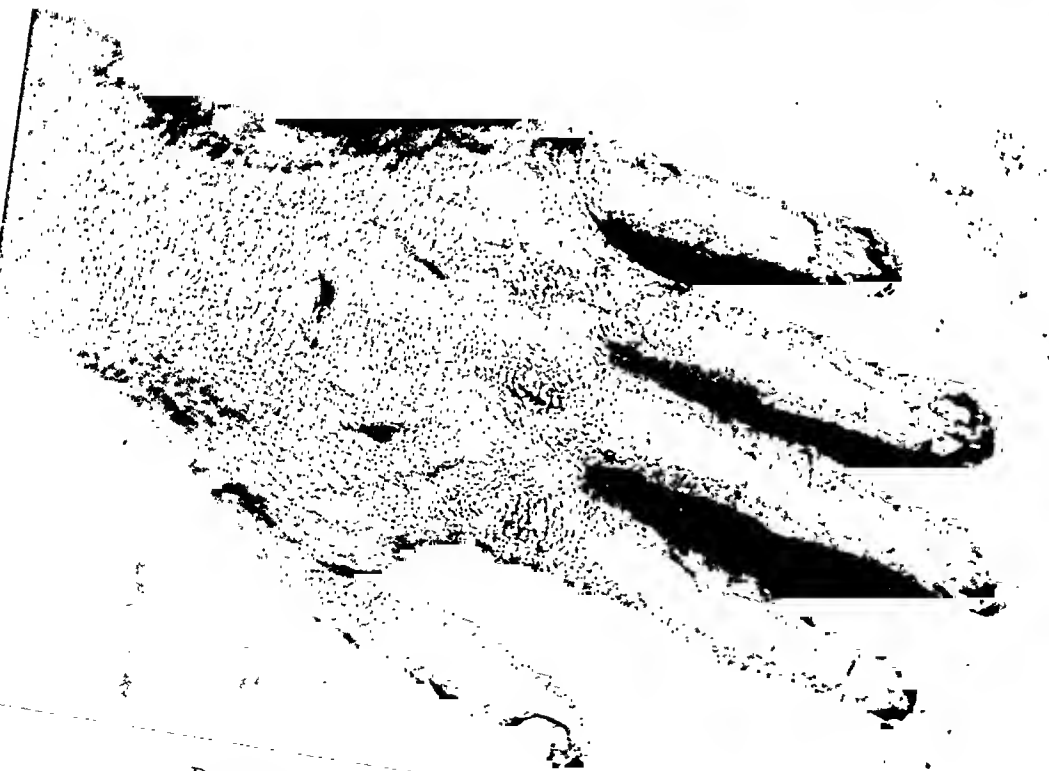
# THE TUNNEL SKIN GRAFT



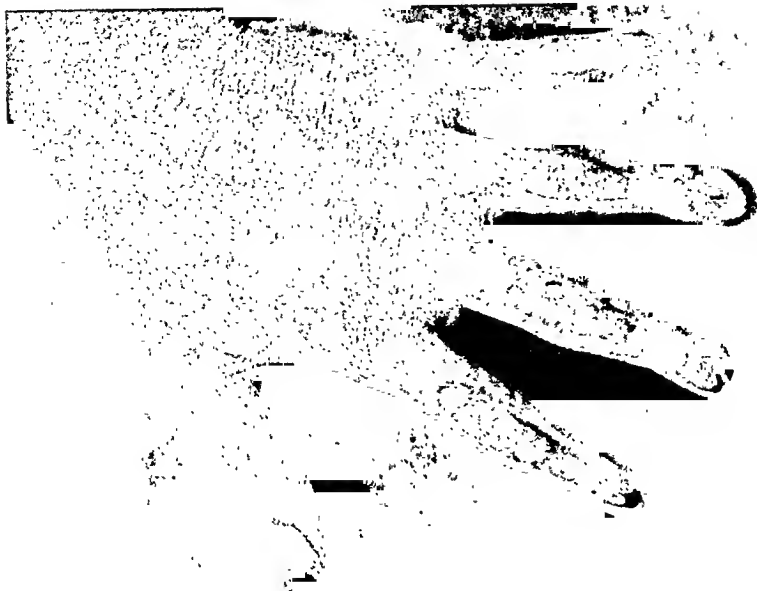
Scar tissue contraction incident to burn before the application of tunnel graft.



Two years after the application of tunnel graft.



Destructive gasoline burn dorsal skin of fingers.



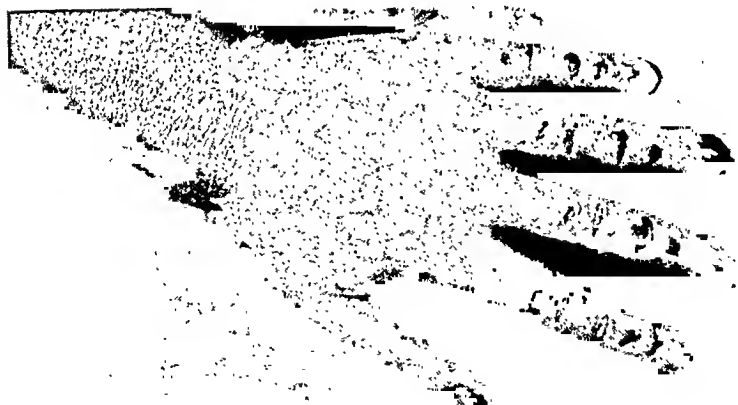
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Appearance of grafts three weeks later.



Tunnel grafts cut out on the sixteenth day.



Full thickness tunnel grafts in position.

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Posterior view contractile bands, following gaso-  
line burn.



Lateral view.



Contractile scar eliminated by two tunnel  
grafts.



the reestablishment of the circulation. The tunnel graft has in addition been used in anal, annular and rectal strictures, and will be the subject of a future paper if the strictures do not recur after a reasonable period.

The technic now used is much simpler than that used in our earlier cases, but necessarily varies somewhat according to the location of the tunnel or the condition for which the graft is used. The same general rules of skin grafting apply in this method as in the various classical methods. The



Granulating surface ready for full thickness tunnel grafts.

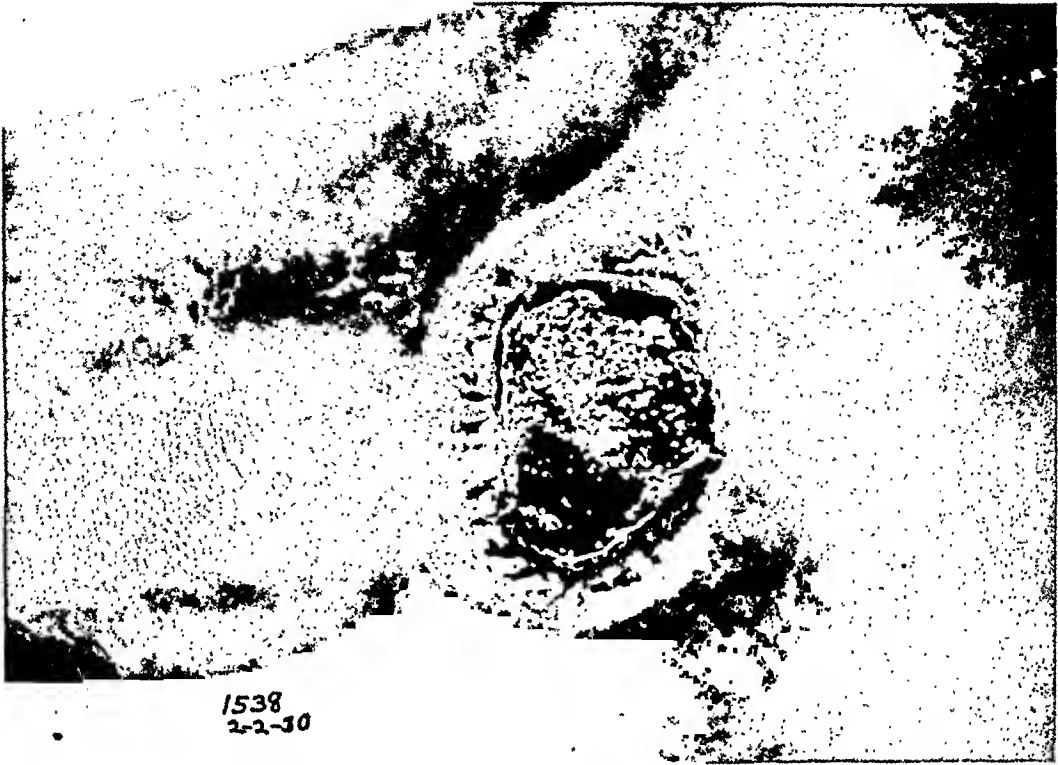
Nine grafts each nearly one-half inch wide when cut, contracted to almost half that width before introduced into the tunnel. Contracted graft permits more stretching during motion.

source of the graft is unimportant except due consideration should be given to the location as to texture, hairlessness and other features according to the position of the graft. The use of the autograft is imperative.

The skin of the area from which the graft is to be taken and the area which is to be grafted are prepared the day before by washing with green soap and water, shaved if necessary, cleaned with ether and alcohol, painted with half-strength tincture of iodine, the iodine removed with alcohol and the part covered with a sterile dressing. When grafts are to be placed under ulcers or granulating tissue the surface should be treated with Dakin's solu-

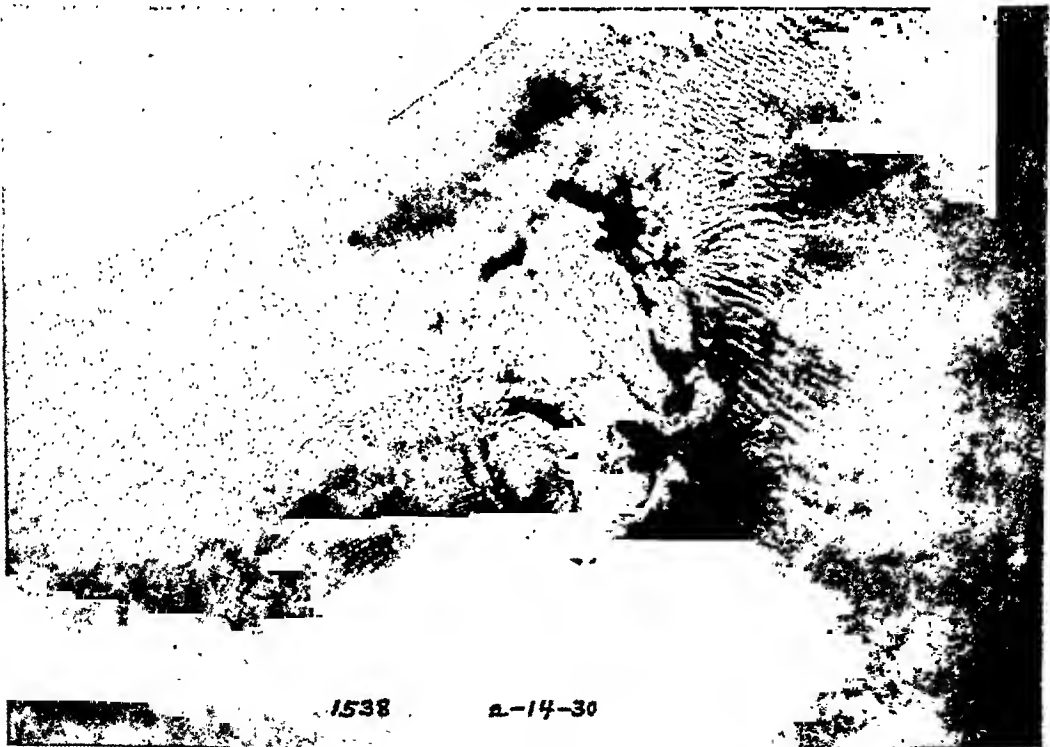
## THE TUNNEL SKIN GRAFT

tion or otherwise for several days, and any deleterious effect of the antiseptics need not be feared when using the tunnel graft.



Granulating surface (of ankle) ready for full thickness tunnel graft.

The graft is outlined on the skin, of a size estimated to be necessary, and carefully and gently dissected from the area with a sharp knife, obtain-



Five days after operation, showing partial absorption and tunnel of granulation tissue.

ing a graft as fat free as possible. The smaller grafts may be cut out with a curved scissors and fat removed (Fig. 5). At first the skin to be trans-

planted was sewn over a flat piece of dental compound or over a metallic plate with the skin surface turned inside out before it was introduced into the



Ten days after graft. Almost complete absorption of granulating tunnel. tunnel, but this has been discarded. Now all grafts are simply placed in the tunnel with the raw surface in contact with the surface to be grafted.



Three weeks after grafting. Skin normal in appearance and wound perfectly healed. In cases of large contracted bands of scar tissue in the axillary folds or in the thigh where a wide graft is necessary, the use of a large trocar and

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cannula simplifies the operation and is accomplished by passing the trocar beneath the scar tissue requiring division and removing the male portion, leaving the female part in place. The full thickness graft, free from fat,

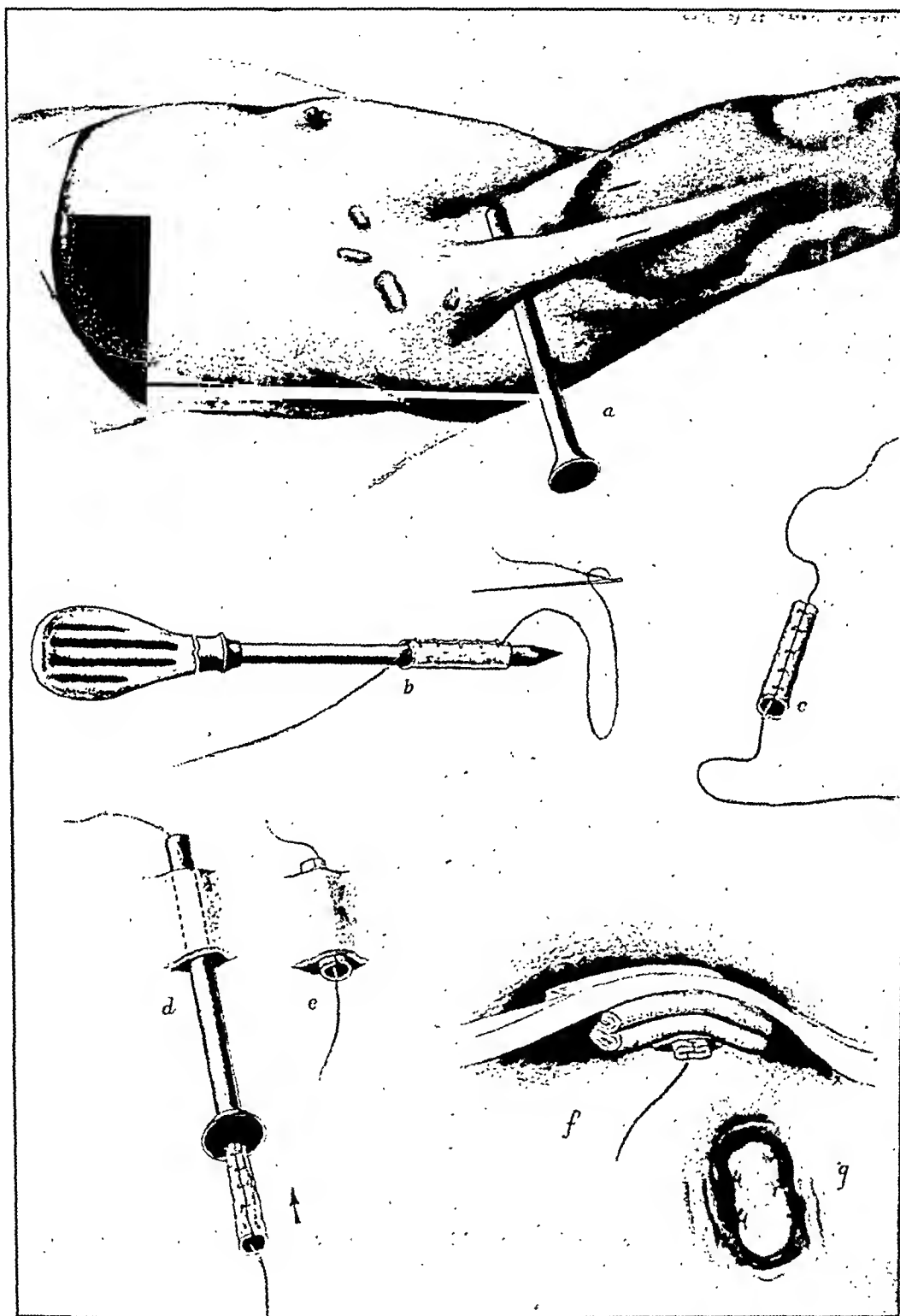


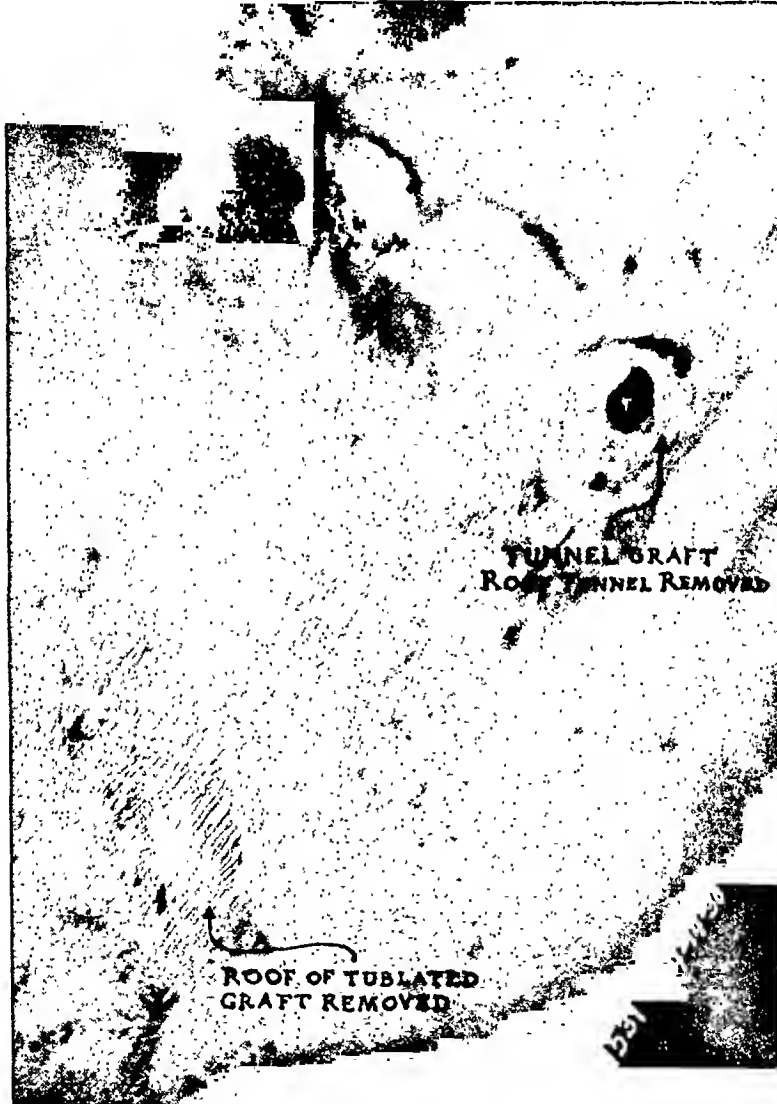
PLATE I.—Technic of introduction of tubulated graft. "G" represents occasional suture from skin margin to graft after tunnel is removed. (Trocar too small)

is tubulated by sewing it over the male portion of the cannula with the skin surface toward the metal. The sutures are left long at each end for future use in guiding the graft through the cannula while the latter is being



removed (Plate 1). This method of introduction insures less hæmorrhage and more uniform pressure by the surrounding tissues than when the tunnel is made with a cutting instrument as is often necessary when grafting the fingers and other surfaces with little areolar tissue.

When grafts are used under granulating tissue or under ulcers, the tunnel is made by passing a narrow scalpel between the granulating tissue and the



Result of case shown in Plate 1. Elimination of contractile band of posterior axillary line.

vascular membrane with the flat surface of the knife hugging the membrane. The graft is not tubulated as when used under such tissue, but is introduced flat, singly, or in a series of separate spaces over the ulcer or granulating surface (Fig. 8). In some cases the granulation tissue may show some discoloration on being separated by the scalpel from the underlying vascular tissue.

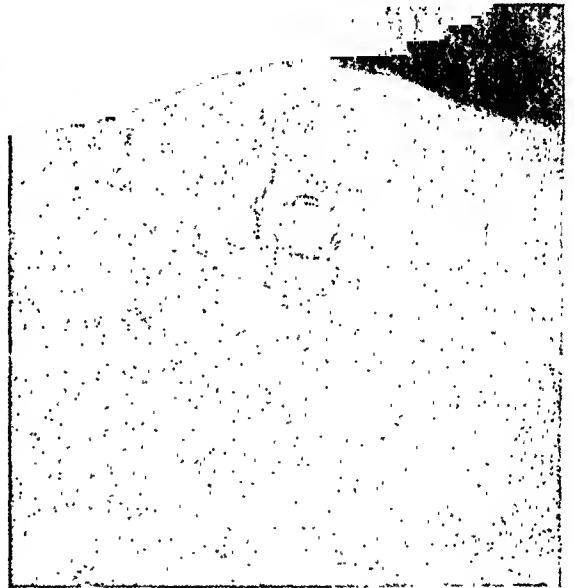
The operation completed, the area over the graft is covered with five

## THE TUNNEL SKIN GRAFT

layers of gauze impregnated with vaseline, held in place by a tight bandage and the limb or part splinted. The bandage is tightened on the fourth day and the dressing is not removed for two weeks if the tunnel is under scar tissue. When used under granulation tissue or under an ulcer, the dressing may have to be changed earlier and in these cases the bridge of tissue forming the roof of the tunnel may partially disappear by the fifth day, owing to maceration incident to secretion and necessary pressure. Such cases are dressed on the fifth day when the vaseline pad is changed, and are not disturbed again for another five days. On the fifteenth day the roof of the tunnel is divided in the mid-line of a flat graft or over the line of sutures of a tubulated graft. The edges are trimmed or simply allowed to atrophy, the parts are flushed with 10 per cent. argyrol solution and the



Chronic ulcer in the centre of old scar, following burn.



Four weeks after. On the surface above graft will be seen many grafts introduced during the granulating period to prevent scar tissue contraction incident to fibrosis.

vaseline gauze reapplied. If desired, the grafts may be exposed to the air, protected by a wire gauze screen for a week.

The tunnel method of skin grafting seems to offer several advantages compared with the various classical methods. It is most useful in depressions or folds of the body, such as the axilla and other locations where superficial grafts are notoriously difficult to maintain in accurate apposition, and this graft can be applied beneath a granulating surface more successfully than a superficial graft can be used on top. The vitality of the graft seems greater and, if necessary, dressings may be removed whenever desired, even within twenty-four hours, without disturbing the graft. This is particularly useful when the surface is potentially infected as when used beneath a chronic indolent ulcer. With this method, close apposition is assured, movement less likely, accurate cutting and fitting is unnecessary, and the maintenance of proper tension is no problem.

Where Dakin's solution or other antiseptic is used in preparing the

surface to be grafted, the tunnel graft is more likely to take as it seems to be less affected than a surface graft. The whole procedure is quicker and less tedious than the classical methods, the surface to be grafted is more easily prepared, and there is less hæmorrhage, which is sometimes of distinct advantage.

One of the most important uses of this method of skin grafting is in overcoming the contracture of old scars. In these cases the removal of all scar tissue is unnecessary in preparing for the reception of the graft and, being a whole thickness graft, the usual layer of fat is soon developed and adherence to the underlying tissue is unlikely. The graft is freely movable, elastic, and capable of adjusting itself to a movable contour of underlying parts.

This type of graft has been more universally successful in its growth than any other type used by the writer. The reason why such grafts are so successful has not been determined, but their very satisfactory growth might in a measure be due to the fact that the graft once in position is fixed on all sides, so that it cannot be displaced and it is protected from trauma during the early period of its growth. It is completely surrounded by living tissue and, as any graft must subsist on lymph for several days, the plasma circulation is more efficient and completely bathes the transplant within its tunnel, furnishing an ideal environment, as no better medium could possibly be obtained for the preservation of the grafted tissue. It seems probable also that the capillary circulation is more quickly established and the period of defective nutrition shortened or postponed.

#### REFERENCE

- <sup>1</sup> Parce, A. D., M.D., Major, Medical Corps, U. S. A.: An Improved Method of Skin Grafting, *ANNALS OF SURGERY*, p. 658, June, 1922.

# END-RESULTS IN BUNION SURGERY

BY LEONARD BARNARD, M.D.

OF OAKLAND, CALIF.

FROM THE ORTHOPEDIC DEPARTMENT OF THE STATE UNIVERSITY OF IOWA CHILDREN'S HOSPITAL

IN THE Orthopedic Department of the State University of Iowa on the service of Dr. Arthur Steindler, during the years from 1916 to 1929, there were performed approximately two hundred and forty-six operations for Hallux Valgus. Of this number two hundred and nineteen have been followed for varying periods from a few weeks to ten years, and one hundred and seventy-two have a follow-up of one or more years. From these two groups an attempt will be made to evaluate the various procedures as practiced in this clinic. The cases were all operated upon by house and staff surgeons, the former group being a changing one from year to year. Most of the cases were from clinic groups, but a considerable number were private cases, so that they may be said to represent a fair cross section of an average surgical practice.

*Classification.*—All bunions fall generally into the groupings of static, arthritic, and paralytic, in that the production of the deformity is associated intimately with one or the other. This neglects only the traumatic which are really very rare and for practical purposes may be omitted.

We will not attempt to enter into the determination of the factors and theories of the static type, but will confine ourselves to the consequences of the surgical therapy.

*Symptoms.*—The major symptom is pain in practically all cases. Deformation, difficulty in walking, inability to get proper or comfortable shoes, recurrent swelling and abscess formation were among the most common accompanying complaints. The duration of symptoms varied from a few months to years. In the static group the duration of deformity was in several cases from childhood.

About 30 per cent. of the static deformity had a concurrent ankle valgus or metatarsalgia. In the arthritic group the lesion was usually combined with other marked deformities, which was also true of the paralytic.

*Surgical procedures.*—The most commonly used method of bunionectomy is that known as the Mayo-Hueter operation. This involves resection of the metatarsal head and the swinging in of an adductor flap to produce an arthroplastic effect. Another very much used method is that of Silver, which is essentially the removal of the exostosis and the shortening of the adductor flap in resuturing it. In the Porter procedure the exostosis is chiseled off and a purse-string suture thrown around the adductor orifice to draw this ligament tense.

The oldest method is that of excision of the exostosis. There are many others, such as the Kellar, which involves resection of the phalanx, and the

Ludloff, which osteotomizes the metatarsal shaft to obtain correction. Similarly many modifications involve plastic work upon the soft structures about the joint.

In this series the procedures will be confined to the (1) Mayo-Hueter, (2) Silver, (3) Porter, and (4) Excision of exostosis.

*Definition of results.*—In this group a *good* result shall be considered as one in which there is absence of pain, free mobility of the joint, and one which is free from deformity.

A *fair* result is that which has absent or only occasional mild pain, moderate limitation of joint motion, small return of deformity, but which is generally a better foot than prior to the operation.

A *poor* result is defined as that which has not improved, has recurred, has persistent pain, or has such limitation of motion of the great toe as to interfere with function.

In all the statistics, unless specified, the operation refers to the individual foot and not to the patients. The percentages are reported in round numbers, no attempt being made to add fractions.

*Patients.*—The two hundred and nineteen operations were performed on a total of one hundred and thirty-five patients. The average age of the patients was 38.9 years, the youngest being 8, and the oldest 67 years of age. In the group the ratio of females to males was approximately 3:1 (163:56). The operation was bilateral in eighty-seven and unilateral in forty-five cases. The right foot was operated upon one hundred and twelve times and the left, one hundred and seven times.

#### TABULAR ANALYSIS OF CASES

	Late Group	Entire Group
<i>1. Type of Bunion</i>		
(Post-operative observation one year or more)		
Static .....	108—62 per cent	149—68 per cent
Arthritic .....	51—29 per cent	53—24 per cent
Paralytic .....	13— 7 per cent	16— 7 per cent
Traumatic .....	0 0	1— 0.4 per cent
Total .....	172 cases	219 cases
<i>2. Type of Operation</i>		
Mayo-Hueter .....	105—61 per cent	134—61 per cent
Silver .....	37—21 per cent	43—19 per cent
Porter .....	18—10 per cent	27—12 per cent
Excision .....	12— 7 per cent	13— 5 per cent
Miscellaneous .....	0— 0	2— 0.9 per cent
<i>3. End-Results All Types Combined</i>		
Good .....	118—68 per cent	177—80 per cent
Fair .....	38—22 per cent	29—13 per cent
Poor .....	16— 8 per cent	13— 6 per cent

# END-RESULTS IN BUNION SURGERY

		Late Group	Entire Group
4. <i>End-Results of Individual Procedures</i>			
A. Mayo-Hueter	Good.....	74—70 per cent	109—80 per cent
	Fair.....	21—20 per cent	19—14 per cent
	Poor.....	10—9 per cent	9—5 per cent
B. Silver.....	Good.....	28—75 per cent	34—79 per cent
	Fair.....	4—10 per cent	4—9 per cent
	Poor.....	5—13 per cent	5—10 per cent
C. Porter.....	Good.....	11—61 per cent	22—81 per cent
	Fair.....	5—27 per cent	4—14 per cent
	Poor.....	2—11 per cent	1—3 per cent
D. Excision.....	Good.....	8—66 per cent	10—76 per cent
	Fair.....	3—25 per cent	2—15 per cent
	Poor.....	1—8 per cent	1—7 per cent

## 5. *Results by Diagnosis in the Late Group*

A. Static.....	Good.....	77—71 per cent
	Fair.....	21—18 per cent
	Poor.....	10—9 per cent
B. Arthritic....	Good.....	35—68 per cent
	Fair.....	11—21 per cent
	Poor.....	5—9 per cent
C. Paralytic....	Good.....	10—76 per cent
	Fair.....	1—7 per cent
	Poor.....	2—15 per cent

As to the value of the different procedures in the different types of diagnosis, no data are obtainable except as regards the static. In this the results seem equally distributed among the four types of operation and show no type to be outstandingly superior. The paralytic cases were practically all the subject of the Mayo-Hueter method, while the arthritics were confined to the Silver and Mayo-Hueter procedures with about equal results.

It is to be remembered that, in evaluating these statistics, the type of operation was chosen to fit each case and no particular method was on trial.

In analyzing the failures, the principal difficulty in the Mayo-Hueter method was stiffening of the joint with pain. In the other methods the return of deformity was more often the cause of failure.

## CONCLUSIONS AND SUMMARY

1. The general distrust in operation for Hallux Valgus is not justified. The low percentage of poor results (less than 10 per cent.) is better than in most surgical procedures and warrants the conclusion that these operations stand on firm ground.

2. Pain is the most constant presenting symptom, and the cosmetic factors are of secondary importance.

3. Two types of end-results are presented, one in which the condition on discharge is considered the basis and the other after a period of at least one year has elapsed. This has served to show that the late results are not as good as the early, and accentuates the importance of using late results as the criteria of procedure.

4. Generally speaking, the results of the Mayo-Hueter and Silver operations have been the most satisfactory over the longer period. However, the small number of cases in some of the groups must be considered before they are condemned.

5. The individual operations show little variation in their value in considering the different types of bunions, *i.e.*, whether static, arthritic, or paralytic.

6. The results in this group were best in paralytic, next in static, and poorest in arthritic. The variation is, however, less than is usually presented.

7. The selection of type of operation should be made to fit the individual case, and we cannot hope for a single procedure to be satisfactory in all cases.

# TRANSACTIONS OF THE PHILADELPHIA ACADEMY OF SURGERY AND THE NEW YORK SURGICAL SOCIETY

ANNUAL CONJOINT MEETING HELD FEBRUARY 13, 1930 AT PHILADELPHIA

DR. GEORGE P. MULLER, President of the Philadelphia Academy of  
Surgery in the Chair

CALVIN M. SMYTH, JR., M.D., RECORDER

## COAGULATION OF BLOOD

DR. ISIDOR S. RAVDIN, of Philadelphia, read a paper entitled  
THE COMPARATIVE VALUES OF CALCIUM AND GLUCOSE AS AGENTS  
FOR DECREASING THE CLOTTING TIME OF BLOOD  
for which see page 801

DR. FREDERICK W. BANCROFT, of New York City, remarked that at the Fifth Avenue Hospital in New York for the last three years they have been making studies of thrombosis and embolism with the idea of learning something about these conditions.

It was found that the bleeders could be divided into two groups: those definitely hæmophiliac with a low blood platelet count; and others with nutritional bleeding. It was found that the ordinary clotting time did not give a true index of the patient's bleeding reaction. Nutritional bleeders, on a high protein diet, regain their normal factors and become satisfactory operative risks. A number of tonsillectomies were referred for bleeding, and after placing them on a high protein diet, particularly liver, pancreas, brain, etc., it was possible to reduce the clotting time. Another type was the case of uterine bleeding without obvious pathological lesion—patients who had been curetted numerous times and in whom the bleeding still continued. When placed on a high protein diet the uterine bleeding ceased, but when the diet was not followed it started again. As it is extremely difficult to place post-operative patients on a suitable bleeding or clotting diet Doctor Bancroft has been experimenting to determine what drugs might influence this condition. In dogs he has found that the administration of glycocholate will definitely improve the clotting factors and shorten the bleeding time. In a study of patients suffering from thrombosis and embolism (the opposite pole of the bleeding problem) he finds that thrombosis and embolism are rare following operation in parts of the body where there is no active motion. For instance, in skull operations, even though the operation occurs in a vascular area, post-operative pulmonary complications are exceedingly rare. In operations on the abdomen, where post-operatively there is extreme motion due to vomiting and distention and where there is a great deal of subcutaneous fat, thrombosis and embolism are frequent. It occurred to the speaker that the fat might have something to do with the production of



embolism. By injecting an emulsion of fat into dogs, he found a tremendous increase in clotting factors. He has wondered whether emulsion of fat that occurs due to operative trauma may not be a factor in the causation of thrombosis and embolism.

Glucose in the concentrations given for post-operative shock have been the basis of study by Doctor Rosenthal, of Mt. Sinai Hospital. He has not found any change in the bleeding or clotting time following this procedure. In dogs they have carefully tested the clotting factors following intravenous glucose in concentrations of 5 and 10 per cent. without any noticeable change. Doctor Bancroft believes with Doctor Hunt, of the Otolaryngeal Service at the Fifth Avenue Hospital, that the bleeding and clotting time is not a true indication of a patient's bleeding susceptibility.

#### BONE METASTASIS IN CANCER OF THE BREAST

DR. JOHN BERTON CARNETT, of Philadelphia, read a paper with the above title for which we see page 811.

DR. BURTON J. LEE, of New York City, remarked that recently a survey was made, at the Memorial Hospital in New York, of 100 cases of carcinoma of the breast with metastasis to the osseous system. Fourteen of these patients had an involvement of the humerus, upper portion of the sternum or clavicle. Further study of these fourteen cases revealed that but three showed metastasis to one or more of these bones on the same side as the lesion of the breast, while in eleven of the patients the cancer of the breast was on the opposite side to the lesion or lesions in these bones. The lowermost axillary nodes connect with lymphatics down the arm to the vicinity of the nutrient foramen of the humerus so that any invasion of the humerus above this point might be accounted for by lymphatic extension.

Lymphatic permeation to bone from carcinoma of the breast would appear a probable method of extension if the most reasonable line of lymphatic permeation is found in the majority of cases, a finding not in accord with our study of these fourteen cases. Upon the other hand, he recalled a patient with a large mass of metastatic supraclavicular nodes who developed, at the end of two years, a definite extension to the clavicle immediately adjacent to the invaded nodes. In this case one had a clear demonstration of an extension by lymphatic permeation from the nodes directly into bone.

Lymphatic extension to bone in cases of mammary cancer does occur but Doctor Lee does not feel that it will be found with as great regularity as Doctor Carnett's paper would lead one to believe.

DR. GEORGE SEMKEN, of New York City, said that it is highly improbable that the bony metastases that occur in cases of cancer of the breast can be ascribed to permeation via the lymphatic channels, mainly because of the absence of any demonstrable lymphatic connection of this type. It seems more logical to ascribe these metastases to emboli of cancer cells, carried to the bones in the blood-stream. This mechanism was conclusively demonstrated by M. B. Schmidt in his monograph upon the methods of dissemina-

tion of cancer ("Die Verbreitungswege der Karzinome," etc., Jena, 1903), the significant finding in which was the frequent and widespread occurrence of such cancer emboli in the small arteries of the lung parenchyma.

The apparent predilection of cancer metastases for sites within the substance of the bones may be explained by the relative quiescence of those regions. Cancer metastases are rarely found in the skeletal muscles, which are in active motion. It is possible, thus, that Doctor Carnett's observation of a low incidence of cancer metastases below the knees and below the elbows may be explained by the increased range and activity of motion in the legs and feet and in the forearms and hands as against those of the thighs and arms respectively.

Doctor Carnett's finding of an apparent tendency of the metastases from cancers of the breast to invade the neighboring bones—the clavicle, humerus and the ribs—before appearing in the os innominatum, femur and other distant bones, is not in agreement with the speaker's experience. The bone sites most frequently involved in metastasis, that have come under his observation, have been the vertebræ and, next in order, the os innominatum and the upper femur. The vertebræ, in some instances, seemed to be the only bones so attacked.

The subject of cancer emboli, transmitted via the blood-stream has received little consideration, but deserves the greatest emphasis, and should be ever present in the minds of all who palpate the cancerous breast to establish the diagnosis, and who handle the breast and its related tissues during the course of the radical operation. Breast cancer advances not alone along the lymph-spaces into the lymphatic vessels, but it regularly invades the veins also, filling their lumen to a greater or less extent with cancer thrombi. It does not require much force to dislodge these thrombi and to send the cancer emboli into the blood-stream. Many of these cells fail to survive, especially if enclosed in a blood clot, but others remain unenclosed or grow through the clot and the distant metastases are the result. The finding of such cancer thrombi in the cancerous breasts removed by operation is so frequent an occurrence that the pathologist's report of such findings no longer excites any comment—except the doubt that thus arises as to the ultimate prognosis. It has been fairly well understood that the cancerous breast should be examined gently; but too many still disregard this caution in a wholly unnecessary attempt to determine the consistency of the tumor by firm pressure especially between the thumb and fingers. Equally important and probably deserving of greater emphasis, is the need to handle the breast with the greatest gentleness during its removal, even at the expense of technical inconvenience. He was firmly convinced that many metastases have had their start in the injudicious pressure or traction exerted by the surgeon or his assistants during these operations, as well as during the course of the clinical examinations.

DR. JOHN B. CARNETT, in closing the discussion on his paper, said that the last case came to autopsy and the bone showed cancer. It might be a combination of the two, but whether or not Paget's disease was present he

does not know, but he does know that one gets this picture uniformly in metastasis to bone. The speaker was not able in the short time at his disposal to go into the various reasons for believing that this is permeation rather than blood-stream metastasis. In the case of breast cancer one can predict with comparative certainty what it is likely to do. One is sure that it will not show up first below the knee or below the elbow in the great majority of cases. This one case with advanced disease below the knee is unique in Carnett's experience. If one sees destruction of the femur other evidences of permeation are seen in between. In osteomyelitis the blood-borne infection to the tibia is common; if that is true one would expect the same thing in blood-borne emboli. It happens almost never except in this case and one practically never finds disease below the elbow or below the knee, except that centrifugal spread from the shoulder down the length of the humerus and some of the femur before the disease passes over the joint. The reason that it appears in the tibia and radius before the extreme lower end of the femur or humerus is involved is because the cells go over the lymphatics in the soft tissues of the joint more rapidly than down through the bone.

#### OSTEITIS FIBROSA

DR. ELRIDGE L. ELIASON, of Philadelphia, read a paper with the above title for which see page 833.

DR. JOHN DOUGLAS, of New York City, remarked that this subject is of particular interest because there is so much confusion as to the various ideas of etiology and pathology. It is known that osteitis fibrosa occurs most frequently in children who are most apt to meet with trauma of various kinds and the lesions are most apt to occur where trauma is most frequent. It is sometimes difficult to link up the history of the trauma with the presence and size of the lesion. A history of severe trauma is sometimes so far back that it has no relation apparently to the lesion present. In other cases, trauma a short time before the appearance of the lesion may not have been the cause of the lesion but simply may have called attention of the patient to the lesion.

Of the three theories as to etiology and pathology which have been enumerated by Doctor Eliason, *viz.*, traumatism, infection, a type of new growth (some form of pathological lesion due to the formation of new tissue), there are evidences which make it difficult to controvert any of these theories, but the weakest is the etiologic factor of infection. It does not act like an infection. Cultures have been made and no organisms found and the curious way in which the lesion spreads after removal or heals after a fracture when nothing else is done does not resemble what one would expect in an infectious process or a neoplastic lesion.

Whether these various lesions are all progressive stages of one condition or whether the lesion starts as a definite pathological entity is hard to explain. In some cases a large number of giant cells are found and in others very few. The essential pathology according to Ewing is replacement of bone marrow

and the inner portion of the cortex by fibrous tissue. It may continue to grow as fibrous tissue; it may develop into a cyst. In some cases the fibrous tissue develops into some type of sarcoma and then a cyst develops in the sarcoma. The lesion spreads rapidly sometimes, and sometimes slowly. The differential diagnosis between benign and malignant conditions, between osteitis fibrosa and other forms of lesion in the bone is difficult. But the peculiar trabeculation of the bone as shown by the X-ray in these cases is characteristic.

DOCTOR DOUGLAS then showed lantern slides illustrating the progress in nine cases of this disease which he has had under his care.

DR. FENWICK BEEKMAN, of New York City, said that he had seen but five cases which he could positively say were osteitis fibrosa cystica. Two of these were seen with Doctor Bancroft, on his service, at the Lincoln Hospital. Only two of the patients were operated upon. In four of the five cases, which came under his observation, the patients did not know they had this condition until they sustained a pathological fracture. The diagnosis is difficult. In July, 1914, Barrie, in *Surgery, Gynecology and Obstetrics*, discussed a condition which he called chronic hæmorrhagic osteomyelitis. His description of this condition was similar to that of the so-called giant-cell sarcoma of bone, the microscopic pictures showing the typical histology of a giant-cell tumor. Doctor Eliason's third case impressed the speaker as one of a hæmorrhagic tumor of the bone. Again, he observed a patient some years ago who had a mass in the lower end of the radius, the röntgenogram showing a picture similar to that of one of the cases presented by Doctor Douglas; this later was proved to be syphilis. Bloodgood believes that most of these lesions of osteitis fibrosa cystica are only discovered following a pathological fracture. He also states that the condition will heal by itself, the child growing out of it. In the first case mentioned by Doctor Beekman, he curetted the bony cavity to remove the membrane and followed this with cauterization by carbolic acid. This patient was followed for one and a half years and the condition of the child showed improvement. The second individual had an involvement of the upper end of the femur; the cavity was curetted and a flap of muscle turned into it. During the period in which this patient was observed, one and a half to two years following operation, the condition improved materially, new bone being formed within the cavity. In the three other patients, no operative procedure was undertaken—one of them was lost track of and the other two showed decided improvement over a period of two and a half years.

#### TRAUMATIC RUPTURE OF THE DIAPHRAGM

DR. HENRY P. BROWN, JR., of Philadelphia, presented a colored boy of nineteen years who was admitted to the Presbyterian Hospital after having been injured a short time previously in a motor accident in which he was thrown violently against the steering wheel of his truck. On admission he showed localized tenderness and some rigidity over the upper left quadrant of his abdomen and lower aspect of the left side of his chest. Examination revealed localized tenderness in the above area within

twenty-four hours. Physical signs of a left pneumothorax developed and an X-ray picture apparently confirmed the diagnosis. He progressed satisfactorily until about to be discharged two weeks later when another X-ray suggested herniation of the diaphragm, which was confirmed by gastro-intestinal X-ray.

On operation, the approach to the hernia being through the abdomen, it was found that there was a tear on the left side approximately eight centimetres in diameter extending laterally from the œsophagus. The fundus of the stomach, most of the transverse colon with the omentum, and some of the small intestine were found to be within the chest. Adhesions were present around the edges of the opening in the diaphragm, showing that the condition was of recent origin and not congenital in character. By grasping the edges of the opening with hæmostats, the negative pressure in the chest was overcome and the herniated viscera were reduced within the abdomen. The opening in the diaphragm was closed with interrupted sutures of chromic catgut, reinforced by a continuous layer of the same material. The abdomen was closed without difficulty.

The patient made a normal convalescence and gastro-intestinal studies made two months later revealed that there was no evidence of hernia. An X-ray picture taken eighteen hours after operation showed that the heart, which had been displaced to the right, had resumed its normal position, and there was no evidence of pneumothorax.

DR. HOWARD LILIENTHAL, of New York City, remarked that there are different kinds of so-called hernia of the diaphragm: 1, a congenital absence of the diaphragm (not a hernia in the strict sense); 2, true hernia with peritoneal covering, whether traumatic or not; and 3, traumatic hernia with rupture of the diaphragm and no peritoneal sac. This last is the type which Doctor Brown presented and in which he got such a splendid result.

The speaker feels very humble and can forgive anyone who mistakes a thoracic stomach for a pneumothorax. He has even gone further and has put a needle into such a stomach, thinking it was a pneumothorax. Fortunately, he did not aspirate anything but air. It was a traumatic case. The patient had "indigestion." He was given a test meal and found the same condition as shown here. At operation it was found that he had broken several ribs, one of which had perforated the diaphragm and produced the hernia. Doctor Lilienthal went in between the ribs and was able in spite of the adhesions present to reduce the hernia and even to sew up the hole in the diaphragm except for an area about the size of half a dollar. The assistant at the operation, Doctor Neuhof, suggested that he take a piece of fascia lata and transplant it, which was done with a perfect result. After several cases of hernia of the diaphragm, the speaker is a firm believer in the transthoracic approach rather than the transperitoneal, for a number of reasons. First, the exposure of the parts is perfect and if any adhesions are present one can find them and do away with them. If the hernia is drawn upon from below and there are adhesions in the chest, one must stop the operation or go in from above anyway. One can deal much better with the hole in the diaphragm when it is in plain sight. Another reason is that there is easy access to the phrenic nerve where it passes across the pericardium; by giving it a pinch, the diaphragm will remain still while you are working on it. Even if permanent paralysis of the diaphragm occurs, the

## FRACTURES OF THE MANDIBLE

patient is better off than with a diaphragmatic hernia. Lastly, it is necessary to know that one is not dealing with congenital absence of the diaphragm. He saw one case in which Doctor Lewald, the röntgenologist, was able to diagnose the absence of the diaphragm. The patient, by the way, was a runner.

As to age for operation, Ralph Boerne Bettman, of Chicago, reported a case operated upon by him at the age of three and one-half months for strangulation. He approached through the thorax and did a fine operation, reducing the hernia before he found that he was not able to close the hole in the diaphragm. He cut two ribs and then did not have the slightest trouble in sewing up the diaphragm. This shows how a resourceful surgeon can get around what looks like an insuperable condition.

The speaker thinks that diaphragmatic hernia is much more common than is usually thought to be the case. When a child's digestive system is decidedly disturbed, we owe it to the patient to give it the same chance we would an adult, and to make an X-ray study of the chest, with contrast meal if necessary.

As to the age for operation, what he would prefer to do and what the attending physician would let him do are two different matters. The operative procedure is looked upon by most physicians as a very dangerous one; although it is not nearly so dangerous as to wait until strangulation complicates the case. In the *British Medical Journal* there appeared an article by a Russian surgeon who believes that prolapse of the intestine through the hiatus oesophagis is much more common than we believe, and thinks some of the herniæ in children begin in that way. If there are no symptoms, it might alter his opinion as to when to operate, but usually there are symptoms, and the X-ray examination discovers the presence of the hernia, in which case he thinks it is better to operate early and avoid the dangers of acute strangulation.

## FRACTURES OF THE MANDIBLE

DRS. ROBERT H. IVY and (by invitation) LAWRENCE CURTIS, of Philadelphia, presented cases of fracture of the lower jaw undergoing treatment. Doctor Ivy remarked that in the average textbook on surgery, under fractures of the mandible, considerable space is given to obsolete methods and little to practical modern treatment. Various types of more or less complicated splints are shown, without specific instructions as to their use, except that they can be made by a dentist. But definite practical information as to how to reduce and fix the fragments quickly and efficiently is usually lacking. Surgeons are being confronted with an increasing number of these injuries owing to a combination of rapid transportation and prohibition, and those skilled in making special appliances are seldom immediately available. Hence, it has been their endeavor to foster the employment of simple methods which can be applied readily in the majority of cases by any surgeon willing to give a little thought to the subject. These methods are not original with them, but are adaptations and modifications of those first introduced by Gilmer. He

did not deny that many cases without displacement will do well with a bandage alone, but these would do just as well without a bandage at all. But no head bandage can be put on sufficiently tightly to fix fragments which show a tendency to displacement, without strangling the patient. Instead of a

FIG. 1.



FIG. 2.

FIG. 1.—Radiograph showing ascending ramus and condyle dislocated forward and rotated at right angles. (Case I.)

FIG. 2.—Radiograph showing replacement of condyle and ascending ramus in normal position. (Case I.)

detailed description of the technic, which is to be found in previous publications, they presented three cases, now actually undergoing treatment:

CASE I.—A man, aged twenty-eight, in an automobile accident November 15, 1929, was struck on the left side of the head by the fender of a car. At the Lankenau

## FRACTURES OF THE MANDIBLE

Hospital a deep wound was found beginning behind the left ear, and passing downward over the ascending ramus of the mandible to the neck. The parotid gland and facial nerve branches were severed, and there was a fracture of the mandible at the angle, the ascending ramus and the condyle being dislocated forward and turned at right angles so that the posterior border faced toward the left (Fig. 1). First-aid treatment by Dr. Montgomery Deaver consisted in arrest of hæmorrhage, suture of the ear, and fixation of the lower teeth to the upper by means of brass wires to control the main fragment of the lower jaw. By November 30 the patient had recovered sufficiently to be transferred to the clinic for further treatment. The exposed bone of the ascending ramus had become almost entirely covered by granulation tissue, and practically no suppuration was present. There was almost complete left-sided facial paralysis. The main fragment of the mandible was in fairly good position. The wires on the teeth having worked somewhat loose, it was thought advisable to obtain firmer fixation by applying heavy half-round German silver arches to upper and lower teeth, and in



FIG. 3.—Normal opening of mouth after treatment. (Case I.)



FIG. 4.—Satisfactory occlusion of teeth after treatment. (Case I.)

turn connecting these with finer brass tie-wires. On December 12, at the Graduate Hospital, under ether, the external wound was enlarged, exposing the outer aspect of the displaced ramus and condyle fragment, care being taken not to completely sever the bone from all soft tissue connections. This fragment was then manipulated into correct position, the condyle being brought back to the glenoid fossa. The lower end was brought in contact with the main part of the mandible at the angle, but no attempt at direct fixation was made (Fig. 2). The attachment of the bone fragment to the soft tissues was so precarious that there was little hope of saving it. Healing over the exposed portion of the bone gradually took place with the exception of a small sequestrum near the angle, and on January 29, 1930, the external wound was almost closed. On this date, the connecting wires between the upper and lower teeth were cut and almost complete union between the fragments had taken place. There was good motion at the joint, the mouth opening being at least two-thirds normal (Fig. 3), and the occlusion of upper and lower teeth was satisfactory (Fig. 4). They believe there has been some improvement in the facial paralysis. They expect later to smooth out the depression left in the healing of the wound, and possibly raise the left side of the face by fascia lata strips.



CASE II.—A man, aged forty years, was referred by the University Hospital January 25, 1930, with history of being struck with a blackjack on left side of face four days before. Examination showed nearly all lower teeth to be present, but several upper teeth on left side missing. The lower teeth on the right side up to the mid-line came into good occlusion with the upper ones, but on the left side there was a downward displacement, so that the cutting edge of the left central incisor was at the level of the neck of the right central incisor. Attempts at closure of the teeth showed independent mobility of the two halves of the mandible. X-ray examination revealed a fracture through the symphysis with an angular turn toward the right before reaching the lower border. There was also a vertical fracture from the sigmoid notch down to the angle on the left side, with little or no displacement. Owing to absence of many teeth from the left upper jaw, the ordinary eyelet method of wiring was not suitable,

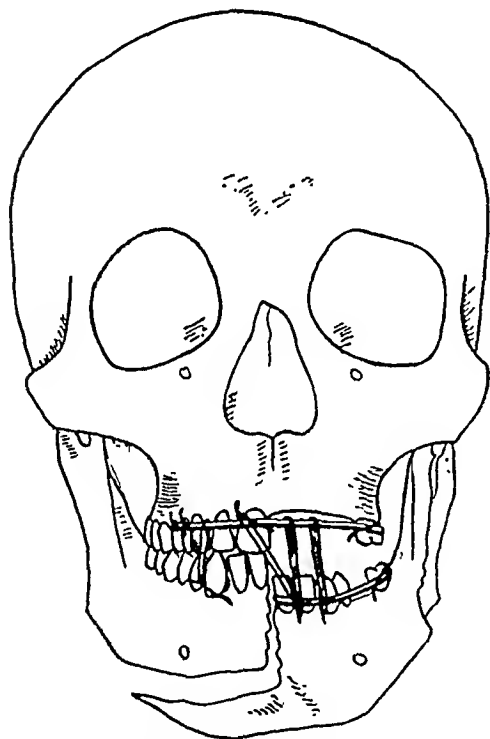


FIG. 5.—Gradual reduction of depressed left fragment by elastic bands. (Case II.)

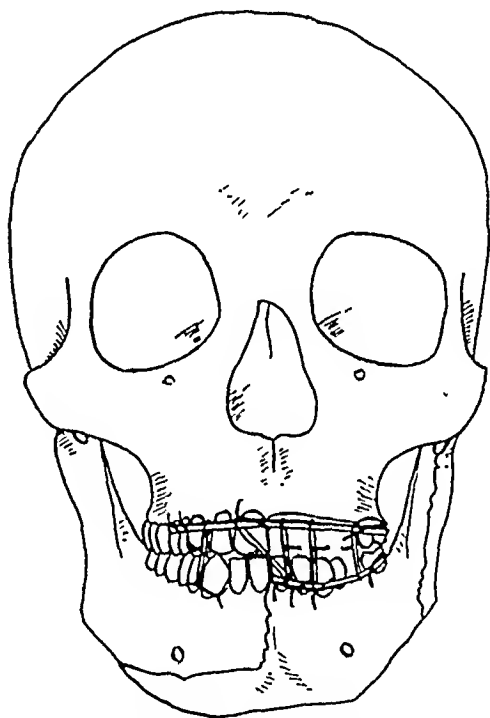


FIG. 6.—Fixation by brass ligature wires after reduction. (Case II.)

so that the somewhat more difficult half-round arch method was used. The case was further complicated by the fact that manipulation would not bring about immediate reduction of the downward displaced left fragment, probably owing to the angular direction of the fracture line. This necessitated gradual traction by means of small elastic bands connecting the upper and lower arches (Fig. 5). At the end of one week, the depressed fragment had been drawn up so that all lower teeth were in good occlusion, and the elastics were replaced by wires (Fig. 6). This gradual reduction by elastic traction is particularly useful in unreduced fractures several weeks old.

CASE III.—A man, aged twenty-nine years, sustained a blow upon his jaw three weeks before admission to the Episcopal Hospital—January 22, 1930. Had received no treatment except a head bandage, and was suffering from insomnia and lack of nourishment. A fracture was found in the right premolar region of the mandible, with marked overlapping of the fragments, the posterior fragment being displaced inward. Considerable suppuration was present. The premolar teeth near the line of fracture had to be removed, and a small incision through the skin made for drainage. Many

## PANCREATIC CYST

teeth were absent, so that fixation was obtained by application of half-round arches to upper and lower teeth. External drainage wound has now healed, and union is progressing satisfactorily, with fragments in good position.

DR. J. J. MOORHEAD, of New York City, remarked that the wiring method as modified by Ivy is simple and effective and much more reliable than the complicated splints such as those of Matas and others. After the immobilization has been done the problem is not complete because every fracture of the lower jaw is essentially a compound fracture and to that end and to that degree osteomyelitis enters into it. The speaker agreed with Doctor Ivy that immediate reduction means easy reduction and that immediate immobilization, properly done by the wiring method, lessens the disability period and is likely to lessen the possibilities of osteomyelitis.

## PANCREATIC CYST

DR. JOHN H. JOPSON, of Philadelphia, reported a case of pancreatic cyst associated with calculous cholecystitis. V. C., sixty-four, white male, was admitted to the Presbyterian Hospital, June 3, 1929. For several years he had been subject to mild intermittent attacks of upper abdominal pain, transitory in nature, and without relation to meals. Two years ago he had an attack of very severe pain, located in the left epigastric region, coming on an hour after eating, not associated with vomiting, which lasted twenty-four hours and required morphia for relief. Four weeks ago he had a second severe attack, followed by vomiting, and lasting longer. He was in bed for three days, and since then he has had almost constant pain in the same region. The bowels, formerly regular, have been extremely constipated. He has lost fifteen pounds in weight. Has no history of jaundice or clay-colored stools. X-rays made elsewhere before admission, and a diagnosis of gastric ulcer and ptosis of stomach and transverse colon reported.

Patient's family and previous medical history were good. He had pneumonia once and operations for carbuncle, and drainage of maxillary antrum. His habits were correct. There was no history of trauma. He was somewhat anæmic and showed signs of recent loss of weight. He was not jaundiced. His physical examination, apart from the abdomen, was practically negative. The abdomen was scaphoid. There was tenderness on deep palpation over the middle and left epigastric regions. No tumor was detected. The liver and spleen were not enlarged. The blood count showed a mild secondary anæmia. The Wassermann and Kahn tests were negative. The blood sugar was 80 and the blood urea nitrogen 13.5. Stool examination negative for occult blood. The gastric analysis gave a maximum free hydrochloric acid of 58, and total acidity of 84. The urine was normal. The blood-pressure was 146/78.

*Operation* June 11, 1929.—Upper rectus incision. No free peritoneal fluid. Liver had rather unusual bluish discoloration on anterior surface. No nodules in it. The gall-bladder was normal in size, somewhat thickened, and filled with small calculi. The common duct was free of stones. Walls of the stomach and duodenum were normal. Behind the stomach, near the mid-line, and situated retroperitoneally was a fixed mass about eight centimeters in diameter, which on palpation was apparently cystic. It was rather difficult at first to establish a line of demarcation between stomach and tumor. A diagnosis was made of cyst of the pancreas. The gall-bladder was first removed in the usual manner. The anterior wall of the cyst was approached through the lesser omentum, after protecting the abdominal cavity by gauze packs. The cyst was aspirated and about four ounces of thin creamy fluid obtained. The inner lining of the cyst was smooth, white and glistening. The cyst cavity was drained externally by a rubber tube, a cigarette drain was placed in the gall-bladder fossa, and a gauze pack used to protect the peritoneal cavity, and control oozing from the lesser omentum.

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Convalescence was smooth. The drainage from the cyst cavity was at first profuse, and straw colored. The gauze packing was not entirely removed until June 22. Following this, cyst drained in lessening amounts, and the tube was first shortened, and finally removed twenty-six days after operation. He was discharged July 12 to the care of his physician. The sinus was small. It drained in scanty and lessening amounts for about a month, and then closed. The laboratory reported the fluid as follows: color bloody, odor foul, reaction alkaline, cell count red blood cells 73,600, white blood cells 600, fites red, albumen a trace, sugar negative, amylose +4. (Only one ferment tested.) Many thick bacilli seen on smear, gram negative organisms, and a few short chain streptococci. (It seems probable that the specimen underwent subsequent contamination.) Patient reports by letter, February 7, 1930, as enjoying exceptionally good health.

DOCTOR JOPSON added that cysts of the pancreas fall into one of a number of types. He would classify this case as a retention cyst for the following reasons: Its apparent location within the body of the gland; the smooth lining, distinguishing it from proliferation, hydatid or dermoid cysts; the nature of its contents, physical and chemical; the association of cholecystitis, possibly a causative agent by production of chronic pancreatitis, which seems to be considered by most authorities as a factor in one way or another in the development of retention cysts. Disease of the gall-bladder, with or without stones, was present in 41 per cent. of cases in Judd's series, although gall-stones were present but once in nineteen cases reported by McWhorter. The above statistics are from Speese's recent article in Nelson's "Surgery." Characteristic symptoms were present. The nature and location of the pain, the associated indigestion and constipation, slow growth, and loss of flesh are quite typical. Jaundice, often a symptom, was absent, as were glycosuria and diabetes, the latter results of associated pancreatitis rather than of cyst itself. Tumor, for some reason, was not detected by any of the examining physicians. The high location of the cyst, in the less usual position above the stomach, was perhaps the reason. It is more usual to have it press forward between the stomach and the transverse colon, as Körte pointed out long ago. The operation of drainage in cysts of the body of the pancreas, with or without removal of the lining membrane, is attended with a low mortality. In this case there was no opportunity to attach it to the abdominal wall and the drainage tract had to be protected by gauze packing. The ability to practise cholecystectomy was fortunate, as Speese points out that cholecystostomy may postpone recurrence and cholecystectomy prevent it.

### HOURLY-GLASS STOMACH

DR. JOHN H. JOPSON presented a woman, aged fifty-four years, who was first seen and first operated upon in 1926 when she was fifty-two years of age. She then gave a history of indigestion extending over many years, in fact, since childhood. After the birth of her first child, twenty-five years before, the symptoms had been very much exaggerated. Her principal complaint was pain in the epigastrium, coming on an hour after eating, and relieved by induced vomiting. The pain was never referred except on one occasion, twelve years ago, when she had hæmorrhages, probably gastric, accompanied by pain in the right shoulder, when she was confined to bed for two weeks. For years she had been very thin, and at the time of her first admission weighed

only ninety-one pounds. The X-ray showed an extreme degree of hour-glass contraction of the stomach, with a large proximal and distal pouch. The first operation was at the Presbyterian Hospital July 19, 1926. Two distinct pathological conditions were found present. There was a marked hour-glass contraction of the stomach, the median portion being stenosed and forming a narrow tube three inches in length, firmly adherent to the under surface of the liver. It apparently represented the site of an old healed ulcer. A more unusual finding was an internal hernia of the small bowel, no evidence of which was present in the X-ray taken before operation, the greater portion of the jejunum and ileum being herniated through a large congenital opening in the transverse mesocolon and another in the right portion of the lesser omentum. The loops of gut lay above the distal pouch of the stomach and between it and the liver. The distal portion of the stomach and the transverse colon were displaced downward toward the pelvis. The opening in the transverse mesocolon was three inches in diameter and just to the right of the ligament of Treitz. The bowel was not adherent and was reduced without difficulty and restored to its normal position below the colon. These openings in the mesocolon and lesser omentum were repaired by suture. The hour-glass contraction of the stomach was treated by gastrogastrostomy, a three-inch opening being made in either pouch. No attempt was made to free the adherent portion of the stomach from its attachment to the liver. The convalescence from this operation was smooth. The patient was relieved from all of her symptoms for two years, and gained considerable weight. At the end of that time she began to suffer with dull pain and swelling in the left lower abdomen. This pain had no relation to eating. She again lost weight, and was readmitted to the Presbyterian Hospital in January, 1929. Physical examination showed a marked degree of emaciation and asthenia, and slight tenderness and some distention in the lower abdomen, left side; otherwise negative. Gastric analysis was normal except for a sub-acidity. The X-ray report was that the gastrogastrostomy opening was very narrow and there was fluoroscopic evidence of pyloric stenosis.

*Operation* February 6, 1929.—There were extensive adhesions around the site of the previous operation. The pylorus was narrow, but there was no evidence of ulceration at that point. After dissection of the adhesions and mobilization of the stomach, an examination of the gastrogastrostomy opening showed it to be somewhat contracted. The recurrence of obstruction at this point was in part due to this narrowing and in part to perigastric adhesions around it. Three operations were considered, namely, partial gastrectomy, sleeve resection, and double gastrojejunostomy. The last operation was decided upon. There was some trouble in obtaining good exposure of the posterior surface of the stomach, but beyond this there was no particular difficulty. The convalescence was uncomplicated. The patient gained weight after discharge, went back to housework, and when examined in September, 1929, had few complaints except some symptoms of eyestrain, in the way of headache, which were relieved by refraction. Since then she reports herself in good health and is now employed steadily at housework.

The most interesting feature to the reporter in this case was the association of openings, probably congenital, in the transverse mesocolon and the lesser omentum, which permitted herniation of the small intestine into the subhepatic region by way of these openings and through the lesser peritoneal cavity. The drag on the pylorus and distal portion of the stomach, which probably resulted from this herniation, may well have had something to do with the development of perigastric adhesions or ulcer in the pars media which were followed by the hour-glass constriction. He had seen one case of pyloric ulcer in association with diaphragmatic hernia in which practically all of the small bowel had herniated into the left pleura. Other cases of this

character have been reported in literature. The case under consideration had suffered almost from childhood from digestive symptoms. This may have been due to persistent or recurrent herniation of this type. The openings were large, and presumably for this reason strangulation had never occurred.

The methods adopted for relief of hour-glass stomach are numerous. At the present time it is probable that the operation of partial gastrectomy, now so popular, has superseded the other procedures in the majority of cases.

Moynihan, whose experience in the treatment of hour-glass stomach embraces over 100 cases, states that it is gradually displacing other methods in his practise, especially when the ulcer is unhealed or is within an accessible area. However, the speaker had always been intrigued by the double gastro-enterostomy operation since Doctor Gibson presented his paper on this subject in 1923. While the operation has not been a popular one, as Gibson pointed out at that time, and while it is probably seldom performed at present, and he had had no other occasion to use it himself, it is interesting to note that both Gibson and Moynihan had excellent results in the cases in which they found justification for its performance.

DR. CHARLES L. GIBSON, of New York City, said that every hour-glass stomach is a problem and usually an individual problem. It is hard to decide what is to be done in each particular case. In addition to the size of the pouch there are very dense adhesions, and possibly, volvulus. He showed a print of an X-ray of a trifid stomach where the diagnosis was missed both in X-ray prior to operation and at operation and a gastro-enterostomy was done for what he believed to be the upper and larger pouch and it failed to reveal the condition of the patient. He has operated on two gratifying cases in whom from long-standing symptoms there was emaciation and great detriment to the health. These cases seemed to be particularly well chosen for this operation who have huge stomachs with pouches of about even size and with a very tight constriction. In both cases the operation was satisfactory. Both were followed for five years, at which time they had regained their health and had gained from 25 to 40 pounds in weight, and could eat everything.

In a third case several years ago he did the operation for long-standing symptoms. There were present two great big pouches. The patient died at the end of seven days. Post-mortem showed the condition to be quite irreparable. Doctor Gibson does not think that double gastro-enterostomy in all cases is the best procedure. The large stomachs with the two large pouches of equal size are the best suited. Then, too, in cases where there is a very small cardiac pouch, high up, the procedure is about all one can do. One must remember that in some cases after the meal gets through from one pouch, it meets with another stricture due to cicatrization of an ulcer at the pylorus.

DR. CARL EGGERS, of New York City, discussing the case of pancreatic cyst, remarked upon the close association between affections of the biliary system and pancreatic disease. Exactly what the relationship is, is not easy

to determine. A temporary block in the lower end of the common duct by a stone or congestion may allow bile to flow into the pancreatic duct, and thus start the trouble. Doctors Mann and Giordano, of the Mayo Clinic, have shown experimentally that only in a very few instances is that probable, because the ducts are more likely to empty separately rather than by a common opening into the duodenum. In a certain percentage, however, there is a common end and it would seem feasible that a block at the papilla of Vater might cause the bile to flow into the pancreatic duct.

Clinically it is a fact that in nearly every case of pancreatic disease one finds associated gall-bladder disease. He had had the good fortune to have a number of cases under his care and in a great majority gall-stones were present and in others cholecystitis was present. In order to exclude infection as a factor in these he had cultures taken of the peritoneal fluid, retroperitoneal fluid, and, where he operated on the gall-bladder, of the gall-bladder, and in every case they were negative for all the different organisms. This seems to show that infection as such plays little or no rôle, in the production of pancreatic disease but rather that it is due to chemical reactions. The onset is sudden and acute and this also speaks against the theory of infection. If a gall-bladder inflammation were present and the cause of the pancreatitis the patient would have a few days of illness preceding the onset of his pancreatic disease.

As to Doctor Jopson's case of pancreatic cyst and calculous cholecystitis, he had seen a few such cases and believed that these cysts are secondary cysts or pseudocysts which develop as a late stage of acute pancreatitis. He had operated upon three patients of this type, one of whom he had followed from the very beginning. He saw her early for an abdominal condition supposed to be either an acute appendicitis or gastric perforation. He made a diagnosis of most likely acute hæmorrhage pancreatitis and advised admission to the hospital. This was refused by the patient and she was treated conservatively for several weeks when a mass developed in the epigastrium which required admission to the hospital. At this time the clinical picture had entirely changed. There was a large mass in the epigastrium. Operation disclosed a large pancreatic cyst behind the stomach. Turbid fluid was removed and floating in it was a necrotic portion of the pancreas. All cultures were negative. The gall-bladder was full of stones but was not disturbed at this time, but it was removed at a later date. It seems that these pancreatic cysts like the one Doctor Jopson has shown are conditions secondary to acute disease in which there is death of a certain amount of the pancreatic tissue. If the head of the pancreas is involved the patient dies. If the tail end is involved it becomes separated as a slough and usually flows out with the drainage of the cyst.

Most of the treatment of pancreatic disease should be preventive by treating the associated gall-bladder disease. This is another argument in favor of operating on patients with gall-stones rather than allowing the condi-

tion to go on. Acute pancreatitis has a high mortality unless operated on early.

DR. JOHN E. JENNINGS, of New York City, remarked that there seems to be a question in Doctor Jopson's first case as to whether the cyst was coincidental or the result of previous pancreatic disease. He had had the same experience as Doctor Eggers following localized pancreatitis. On palpating the pancreas in the course of gall-bladder or gall-duct surgery one sometimes finds indurated localized masses in the pancreas although a diffuse process is the rule. In three different cases of acute hæmorrhagic pancreatitis he found localized hæmorrhages of the pancreas, which did not involve the head. In one case after incision and drainage, a large portion of the pancreas separated, leaving a cyst cavity which took two weeks to heal. The speaker agreed with Doctor Eggers as to the probability of the origin of these cysts. As to his remarks on the cultures taken for the discovery of infection, he asked whether in these studies anaërobic cultures were made. In a few cases in which he had been able to study hæmorrhagic and local septic processes, he was able to find anaërobic bacteria and perhaps an analysis of this situation would help to a better understanding of the more acute inflammations and infections of the pancreas which are so violent, so fatal.

#### SPASMODIC TORTICOLLIS

DR. CHARLES H. FRAZIER read a paper entitled "Interruption of the Afferent System Alone in the Treatment of Spasmodic Torticollis," for which see page 848.

DR. BYRON STOOKEY, of New York, remarked that the greatest advance in modern times in the treatment of torticollis was presented by Doctor Keen in 1890 in Philadelphia, and it is a great pleasure to hear this subject treated in so masterful a manner by Doctor Frazier forty years later.

Torticollis is an extremely ancient disease judging by the deformity of the skulls which have been removed from some of the ancient Egyptian tombs. The lesion producing torticollis may occur at a number of neural levels in the integration of nerve impulses controlling neck movements. Torticollis may be found in lesions of the spinal accessory nerve and in aneurism pressing upon the spinal accessory nerve. Lesions of the cervical cord cause torticollis and may be referred to as spinal reflex torticollis. Lesions of the more ancient motor system, namely the paleokinetic system, especially globus pallidus and the striatum, may cause torticollis as well as lesions of the more recent motor system, namely the motor cortex and pyramidal pathway.

Apart from disturbances of the neural mechanism at these different levels, local processes may produce torticollis. The most noteworthy of these are found in the congenital form thought to be due to faulty position of the foetus *in utero* with damage to the blood supply of the sternocleidomastoid muscle and subsequent scar tissue formation. It has been a disputed point as to whether this could be attributed to faulty position or to injury at the

time of birth. However, in one or two instances the position of the foetus has lead to the diagnosis of wry-neck before the child's birth and in another instance torticollis was found to be present in a child delivered by Cæsarian section which of course rules out the possibility of injury to the sternocleidomastoid muscle by birth. Thus it is fair to infer that congenital wry-neck may be due to the position of the foetus in utero. It is also possible that injury to the sternocleidomastoid muscle may take place at birth and that subsequent scar contraction may produce rotation of the head and limitation of head movements. Many other local causes may be cited producing torticollis, especially those involving bony changes of the cervical vertebræ and local inflammatory conditions of the vertebræ and muscles.

In considering torticollis we are thus confronted with two major groups, those produced by local changes of the muscles or vertebræ and those brought about by a lesion of the neural mechanism. The surgical treatment of torticollis likewise can be divided into two main procedures, those designed to treat the local effects by local tenotomy or myotomy and those intended to interrupt the neural impulses in either its afferent or efferent arc or both. Tenotomy and myotomy are successful in so far as they treat those forms of wry-neck due to local lesions but are totally inadequate for those forms in which the neural mechanism is implicated.

Isaac Minnius, 1641, is credited with having performed the first open section of the tendon of the sternocleidomastoid and Bujalski, 1835, with having first sectioned the spinal accessory nerve though this is usually credited to Campbell de Morgan, 1866.

Operations designed to interrupt the neural impulses were at first limited to section of the spinal accessory nerves, but realizing that this was an inadequate procedure, since the innervation of other neck muscles was involved, Keen, 1890, at the suggestion of Weir Mitchell, sectioned the dorsal branches of the first three cervical nerves after identifying them among the neck muscles. This operation thus cut off both the afferent and efferent supply of the neck muscles since peripheral nerves were sectioned. Thus Keen's operation may be referred to as peripheral section of the innervation of the neck muscles in which both afferent and efferent impulses were destroyed.

In so far as the speaker was aware, the first published report of an attempt to reach the afferent innervation of the neck muscles by hemilaminectomy and intradural section of the dorsal roots of the first four cervical nerves for the treatment of torticollis was made by Alfred S. Taylor, of New York, in 1910, and published in Johnson's "Operative Therapeutics" some years later. Heretofore nerve section for torticollis served both the afferent and efferent arc, whereas by Doctor Taylor's hemilaminectomy the afferent arc only was sectioned intradurally, namely the dorsal roots of the first four cervical nerves and the spinal portion of the spinal accessory nerve.

The patient was still very much improved when last heard from, fourteen years later, although not completely cured. In 1923 Harvey Cushing presented a patient before the meeting of the Society of Neurological Surgeons



in Boston upon whom he had sectioned intradurally the spinal accessory and the dorsal roots of the first four cervical nerves of the same side with great improvement of the torticollis. Doctor Cushing's patient complained of some hoarseness which probably was due to the fact that the spinal accessory nerve was sectioned at the foramen lacerum. Thus after the nerve had received the accessory portion which is derived from the most caudal portion of the nucleus ambiguus which is referred to Edinger's nucleus and supplies the laryngeal musculature, it seems to me that if the spinal accessory is to be cut within the dura it should be cut just below the point at which is received the accessory portion and thus even a temporary paralysis of the laryngeal muscles would be avoided.

Doctor Stookey performed, in 1924, at the Neurological Institute, a hemilaminectomy and a dorsal-root section of the first four cervical nerves together with the spinal accessory upon a patient with spasmodic torticollis. While the patient was considerably improved he was not completely improved and he feels now that were he to repeat this procedure he would certainly do a bilateral dorsal-root section.

Doctor Foerster, of Breslau, has published a series of seven cases surgically treated in which he has done an intradural section of both the ventral and dorsal roots of the first four cervical nerves as well as the spinal accessory for relief of spastic torticollis.

The attempt to destroy the neural arc by sectioning the afferent system alone in so far as the cervical nerves are concerned is, it seems to the speaker, a decided step forward.

#### THE CURABILITY OF CANCER

DR. JOHN B. DEEVER, of Philadelphia, read a paper with the above title for which see page 841.

DR. FRANZ TOREK, of New York, remarked that the question of curability arises every time we have to deal with a case of cancer and, except in cases of very slight malignancy, such as those on the forehead, cheek and the like, the prognosis will have to be guarded. It is difficult to predict what is going to happen, and this has led to the three- and five-year limits of safety; but whatever limits we place, they are perfectly arbitrary. All surgeons had had the experience that some cases show the first manifestations of recurrence later than five years after the operation—some very much later. Doctor Torek remembers one case of sarcoma of the liver which came under observation eleven years after a sarcoma of the eyeball had been removed. With this gloomy side to the picture, one does well to be guarded in prognosis. Fortunately, the cases one sees long after the five-year limits who are well, are much greater in number than the gloomy cases. What one must ask oneself is, are all these patients waiting for a later period in which recurrence is going to come? As long as one is unable to tell what the exact nature and causation of cancer are, the answer to this question will remain more or less uncertain. Those who believe it is a local manifestation of a constitutional disease

will be much more pessimistic than those who believe it is a local disease which later becomes constitutional.

While early surgery is always the important thing, in addition to that it must be as radical as is possible. In this connection the speaker said that a recurrence, meaning thereby a return of the disease after all vestiges of abnormal cell growth have been removed, in his opinion does not take place. A so-called recurrence is an evidence that the riotous cell growth originally present had not been completely removed but that there had remained behind some of the cell growth and had caused the recurrence, so-called. This is in no way a slur at surgery, because our senses are unable to recognize cancerous deposits of a microscopically small size, and in many cases one is unable to tell whether there is a distant metastasis present already. To cite a concrete case: a woman two years and nine months ago was operated upon for uterine cancer and a hysterectomy performed. There was no local recurrence. Last August she began to be unable to swallow solid food. X-ray showed a large tumor with a well-defined outline in the thorax, and the œsophagus was angulated by this tumor to such an extent as to be obstructed. Naturally, at first it was thought to be a metastasis from the uterine cancer, but the outline was so well-defined that both X-ray men and physicians thought it was a well-encapsulated tumor and made a diagnosis of mediastinal dermoid. She was operated upon three and one-half weeks ago and a carcinoma of the lung found. This was resected and the patient made an operative recovery. When did this metastasis take place? It may have been swept by the blood current to the thorax long before the first operation was done, but the speaker is certain that subsequent to a complete removal of the primary cancer it could not have been swept there. One must admit the possibility that it may have been forced into the circulation at the time of the operation by pressure on the diseased organ, and such a possibility is of importance because it throws light on the subject of the curability of cancer as far as it concerns the method of handling the cases. One can be sure that rough handling and forcible retraction of the tumor by a husky assistant could quite probably bring about metastasis. In dealing with malignant tumors it is important to handle them in a gentle way, not only at the time of operation but at the time of examining the patient. Metastasis from the uterus may be caused by the first examination of the patient, if the handling is very rough. It is perfectly well understood that it is necessary to plan and carry out an operation of this kind so that all diseased tissue will be removed, but not so well understood that at the time of removal these cancerous tissues must be handled gently. The surgeon who makes it a habit to handle them gently will have fewer metastases than the one who does not pay any regard to that.

Research into the chemistry of the body may lead to a solution as to the constitutional condition or the susceptibility of certain individuals. Traumatism or chronic irritation is to some extent responsible for the creation of certain cancers, but inasmuch as one knows that the very same kind of

traumatism which seems to produce cancer in some cases, fails to do so in a vast majority of other cases, one feels that there must be a susceptibility or predisposition which acts in certain instances to cause the irritation or trauma to produce the cancer.

### WATER INTOXICATION

DR. ALEXANDER RANDALL, of Philadelphia, called attention to four or five physiological observations to see if any deductions could be drawn from these bearing upon the picture of water ingestion in urological surgery. Taking first a case of benign prostatic hypertrophy as the most uncomplicated picture (as likewise one in which urologists are accustomed to consider a high water intake to be of particular value), he spoke of the clinical picture not infrequently seen either pre-operatively, or post-operatively, in which the patient does not seem to be doing as well as expected, and yet in whom no particular group of symptoms points to complications in the pulmonary system, the circulatory system, or the renal system. This picture is one in which a little lassitude or asthenia suggests that the patient is not at his best—that there may be slight headache, perhaps abdominal distention, hiccough, nausea or even vomiting. This picture does not necessarily have to be in the immediate post-operative period. Carrying this in mind, he asked the audience to correlate with it the following physiological observations that have been scattered in the literature now to be correlated under a possible syndrome, showing that these patients perhaps are suffering from water intoxication.

The subject of water intoxication in man was first presented by Rowntree in 1923, who stated that symptoms of poisoning and the mode of death in higher animals had never been determined. Satiety has been man's safeguard; gastric distress, regurgitation and vomiting protecting him from too great an ingress of fluid. In lower animals it has long been recognized that the salt water mollusk placed in fresh water dies: that the fresh water amœba placed in distilled water likewise dies, and this has been supposed to be due to the diffusion of salts from osmosis. Loeb showed that such an amœba would remain alive if sodium chloride as diluted as 8 to 100,000 be placed in the distilled water.

In Rowntree's animal experimentations he showed that intoxication followed a very definite syndrome of symptoms. Experimental dogs would show asthenia, restlessness, urinary frequency, diarrhœa, nausea, retching, vomiting, tremor, ataxia, coma and death. In man the following train of symptoms occurs: increased blood-pressure, headache, dizziness, restlessness, chills, fullness of the abdomen, vomiting, dyspnœa and peripheral muscle cramps.

Doctor Randall stated that several members of his staff had tested this intoxication by drinking between three and four litres of water in an hour, and that uniformly, each one developed asthenia, headache, and dizziness; the intake being no further pushed in this personal experimentation.

The second physiological observation which Doctor Randall brought forward was the statement made by Crile, that if fluid is pushed to an excess the body protects itself by eliminating it into the stomach from whence regurgitation and vomiting rid the system of such excessive fluid intake.

The third physiological observation to which he drew attention was one recorded by Richards in his studies on renal function. Richards has shown that the glomerular filtrate while passing through the tubules is subjected to a marked reabsorption of both water and certain solids. His experiments showed that glomerular fluid contained higher estimations of chlorides than pelvic urine, and that therefore chloride was one of the products which was normally reabsorbed by the tubule cells. Further experiments demonstrated that the amount of reabsorption of chloride depended to a certain degree upon the length of time that the fluid remained in contact with tubule cells, and that when a marked diuresis was produced there was a greater concentration of chloride in the urine apparently due to the fact that the rapidity of secretion failed to give tubular reabsorption sufficient time to be completed. Therefore, under such marked diureses, the experimental animal lost salts over and above what would normally be eliminated.

Fourthly, Doctor Randall called attention to Edsall's disease, or salt starvation, first described by Edsall, and explained by him to be due to excessive diuresis. Edsall pointed out that men subjected to high temperatures and profuse perspiration, no matter what their occupation, would be found to be imbibing fluids of high salt content, pointing to the heavy beer drinking of the steel mill workers, who often put table salt in their beer; as also the oatmeal water used by harvest hands and football players. Edsall's conclusions were that the symptoms described by him were produced by salt starvation through diuresis and one can now see how closely it is allied with the picture of water intoxication.

Finally, the speaker presented an observation recorded by Austin, Stillman and van Slyke in their studies on urea excretion. These investigators attempted to produce in themselves a high diuresis. On tap water they were able to reach a rate of elimination of eleven litres per diem. This produced great water disgust and could be maintained with difficulty. They found that if they took one-half strength normal salt solution instead of ordinary tap water, that they could drink a great deal larger quantity per diem, that disgust for water was not so marked, and that a diuresis as high as nineteen litres per diem was obtained.

Correlating these various observations with clinical experience and the picture of the prostatic as above cited, Doctor Randall stated that he felt that we possibly overdid the question of water administration in some of these patients whose clinical condition did not appear satisfactory, and in whom no particular complication was demonstrable. Likewise, he stated, that to offset the possible occurrence of water intoxication, he was now having all patients on his service who were on a forced fluid intake given water in which has been dissolved a tablet representing a third strength of Ringer's solution.

They have noted that the patients do not object to such, and Ringer's solution was chosen as it incorporated the other valuable body salts, rather than to use plain salt solution, which might represent but one chemical factor in the picture.

DR. EDWIN BEER, of New York City, said that the recognition of symptoms of water intoxication is very difficult. The tendency to base it upon animal experimentation, as developed by Rowntree's work, is of questionable accuracy. Robert Koch over twenty years ago, while being shown about a New York hospital, saw the water faucets in the various corridors and asked what they were for. He had never seen them in Germany. When the attending physician told him "distilled water for drinking," he said: "Why are you poisoning your staff? Don't you know that distilled water is injurious to the body, not only to the mucous membrane of the mouth but to the œsophagus, the stomach, and wherever it touches?" Much of the earlier animal experimentation was with water distilled in copper and many of the results were invalidated by the fact that damage was caused by the copper in the water. In other cases osmosis was disturbed by the fact that distilled water was not isotonic to the tissues of microscopic animals. When it comes to the higher animals, as well as the lower, a definite set of symptoms develops, such as Rowntree has called attention to: lassitude, dizziness, and if fed on water in large enough quantities a series of symptoms simulating strychnine poisoning will develop. These are all controllable by hypertonic saline solution.

In the treatment of prostatic patients, Doctor Randall has encountered some of these symptoms due, he believes, to an excessive introduction of water. Water per os undoubtedly leads to a train of symptoms difficult to explain! But water subcutaneously and by rectum rarely produces any such syndrome. In Doctor Beer's experience the only prostatic or renal patients who have showed marked disturbance of water metabolism were those who had a high degree of insufficiency; in these it may rarely, or better very rarely, produce such a syndrome that one thinks the patient is going into uræmia. On the other hand, the benefits of water (especially with glucose) by rectum or subcutaneously are so great that one must not be estopped from using it in large quantities. It not only stimulates diuresis but dilutes all poisons. It is well known that crystalloid poisons in great dilution may be introduced without in any way incommoding the body. Although one must be on the lookout for the indications of excess in the use of water by mouth, as well as for the discomfort from ingestion of water, one should bear in mind on the other hand that there is nothing like water, preferably with saline or glucose, to control the intoxication induced by the disease for which the patient is being treated.

# BRIEF COMMUNICATIONS

## THE OPERATIVE TREATMENT FOR INJURED CARTILAGES OF THE KNEE-JOINT

AT VARIOUS clinics in this country and on the Continent I have been struck with the great variation in the technic for the removal of semilunar cartilages from the knee-joints. On the Second Surgical (Cornell) Division at Bellevue Hospital and the Third Orthopedic Division at the Hospital for the Ruptured and Crippled we have, for the past few years, been using a technic for the operation which we believe to have certain definite advantages. The technic has been developed with the aid of Dr. Toufick Nicola. The accompanying drawings and pictures are inserted to clarify the special points of operation.

*Technic.*—The patient is placed on the operating table in a modified Trendelenberg position with the knees flexed to ninety degrees over the end of the table. The operation is always done under a tourniquet. The extremity to be operated upon is draped in such a manner that free motion of the knee is possible in all directions. The surgeon stands at the end of the table facing the flexed knee. An assistant stands on each side of the knee. One assistant retracts the edges of the wound, the other assistant catches the patient's foot with one hand and the patient's thigh above the knee with the other hand, thus being able to rotate the tibia or widen the joint, which materially aids in the removal of the cartilage.

The joint is opened by definitely identifying three layers as follows: (a) The skin incision is made parallel to, and slightly more than a finger's breadth from, the inferio-medial border of the patella. This incision is usually between two and three inches in length (see Plate 1, Fig. A) and about one-third of it is over the tibia and two-thirds of it over the internal condyle of the femur. Beneath the skin there is a fatty layer. Running on top of the capsule there are usually two or three small blood-vessels which may be divided and ligated. (b) The capsule is then cut through (see Plate 1, Fig. B) and the synovia is exposed. Running across the synovia there are two or three small blood-vessels which may be ligated and divided. (c) Synovia is then caught at two points with mouse-tooth forceps (see Plate 1, Fig. C) and opened with knife, extension being made with scissors. A culture at this point is taken. Retractors are put in place and inspection of the joint made.

If it is found necessary to expose the entire joint the upper end of the incision follows around, and parallel to, the superio-medial border of the patella and then along the edge of the quadriceps tendon. The patella is then displaced laterally and the joint exposed as in Plate 2. The incision is thus converted into an inside Murphy,<sup>1</sup> Fisher,<sup>2</sup> Moorhead<sup>3</sup>—the incision

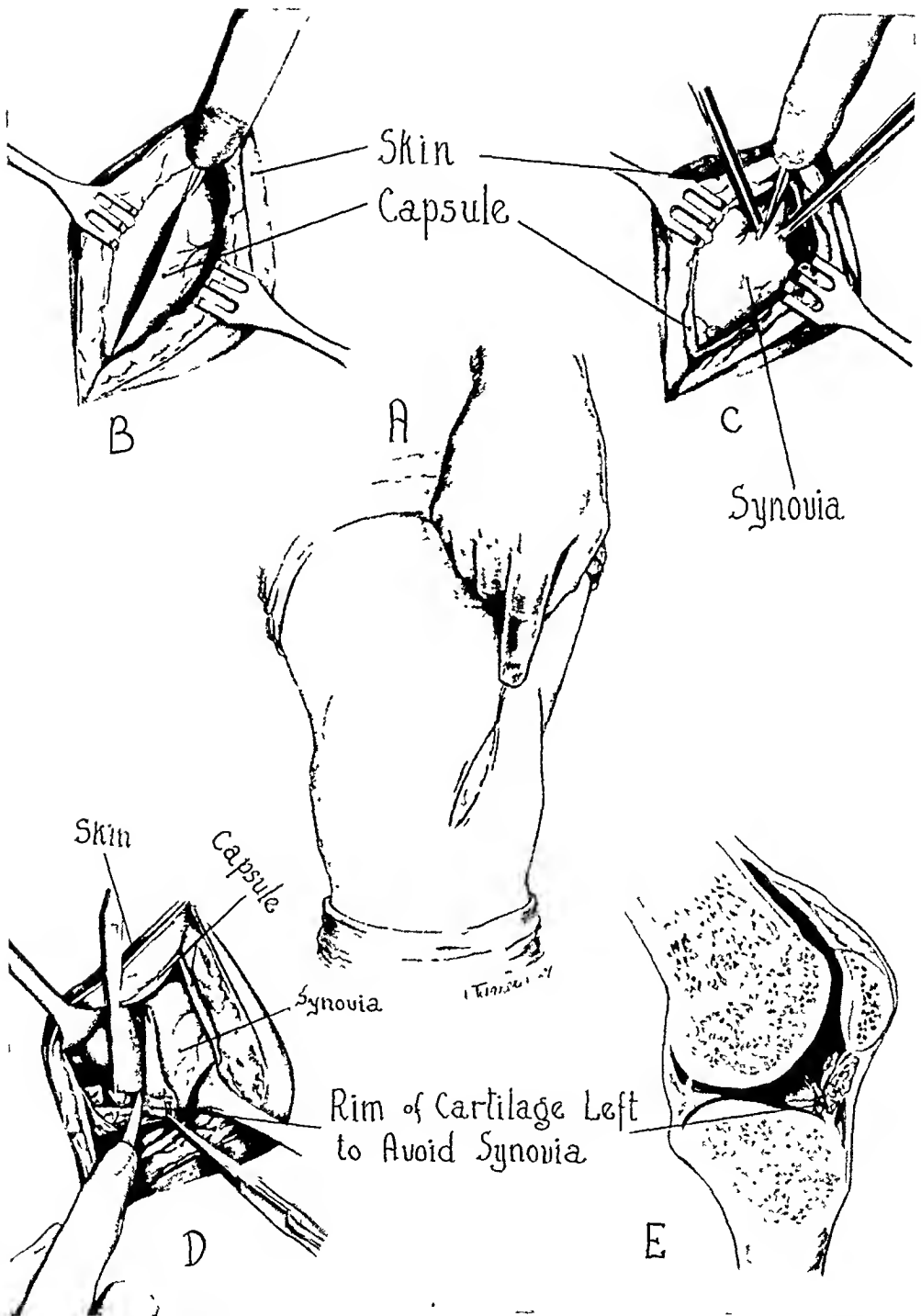


PLATE I.—(A) Skin incision. (B) Skin and fatty layer retracted, capsule cut. (C) Synovia being opened. (D) Cartilage divided transversely and medial portion being excised, slight rim of cartilage being left so as to avoid vascular synovia. Anterior end of cartilage will next be excised. (E) Sagittal view of knee, line of excision of cartilage indicated.

## ARTHROTOMY OF KNEE FOR CARTILAGE INJURY

going by all these names. An actual case where such an extension was necessary is shown in Plate 2. In this case it was necessary to remove (see Plate 3) a growth of cartilage on the inner condyle of the femur, a loose body in the joint, and a fractured semilunar cartilage. When the wound was closed no structure about the knee had been weakened. As an after-result a strong knee with full range of motion was observed one year later.

If only the cartilage needs to be removed it is divided transversely in line

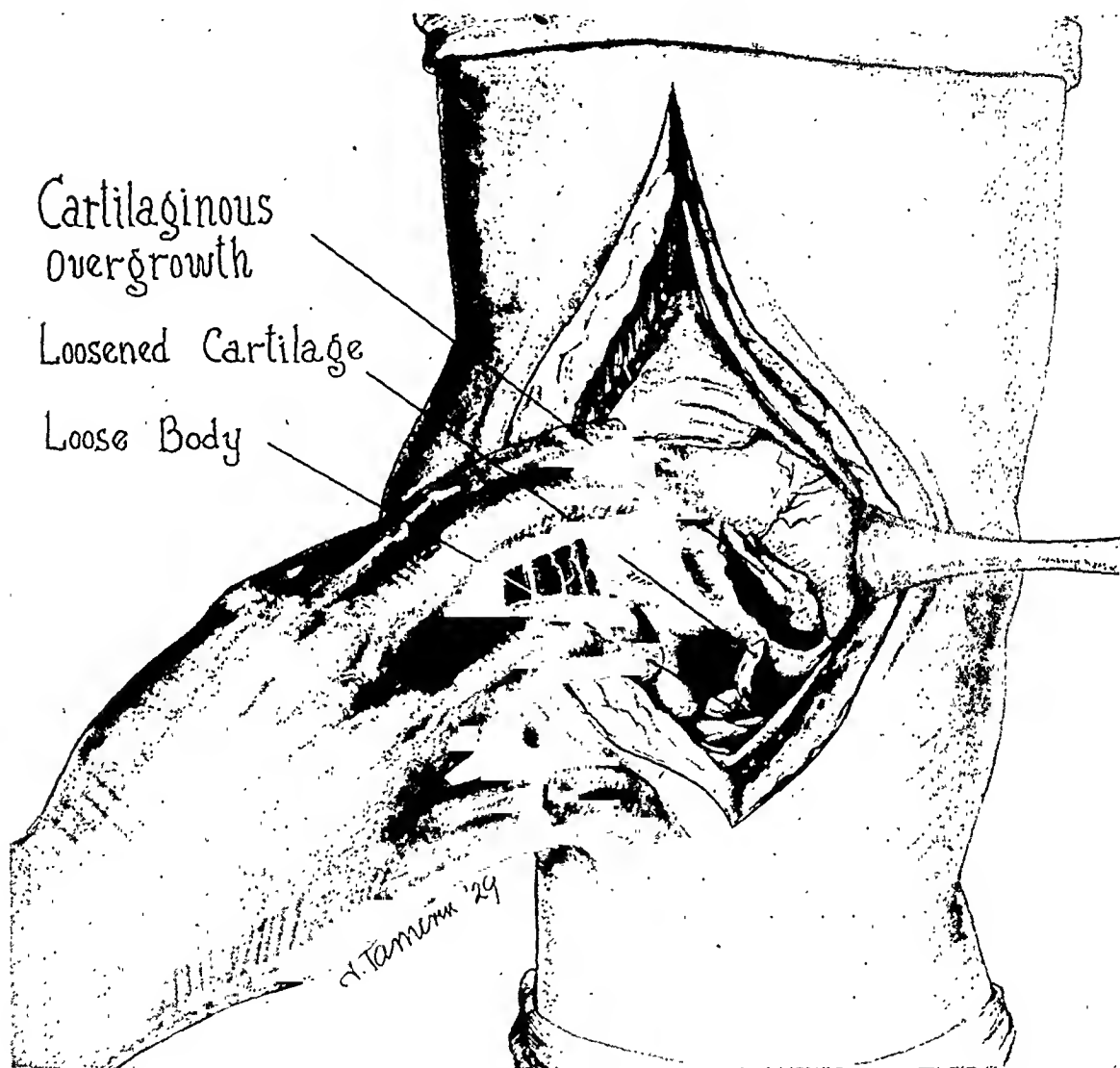


PLATE 2.—R. L., age thirty. A case requiring extension of incision parallel to patella and quadriceps tendon; patella retracted laterally, pathology noted, removed and shown in Plate 3.

with the original incision. This leaves two ends to remove. The synovia blends with the cartilage. The synovia is very vascular. The cartilage is avascular. Therefore in removing the cartilage grasp a cut end with a Kocher clamp and excise, but leave a tiny rim of cartilage remaining at its attachment to the synovia (see Plate 1, Figs. D and E). If the entire cartilage with rim is removed a denuded bleeding synovia is left, there is more or less hæmorrhage into the joint, and the same area will heal more slowly. At the point where the cartilage is torn from its synovial attachment there will be, of course, a gap in the line of excision.



After the cartilage is removed the patient is taken out of the Trendelenberg position and the foot of the table raised so that the extremity is in complete extension. This releases tension on the knee and makes the closure of the wound much easier.

The wound is then closed in three layers: First the synovia with a running number one chromic catgut suture, second the capsule with a similar suture, and third the skin with continuous medium black silk. Some surgeons argue that the capsule should be imbricated. We can see no advantage in this. All it does is decrease the circumference of the capsule of the knee and thus limit flexion of the knee.

After closure the knee is dressed and wrapped with sheet wadding and bandaged from the ankle to the groin. The bandaging is reinforced with adhesive strapping. If the whole knee-joint has been exposed by the extension incision we sometimes put a plaster-of-Paris moulded splint behind the knee.

*After Care.*—The patient is taken to his bed and the extremity is elevated on two soft pillows. Morphine is usually necessary, one quarter grain, repeated sometimes the first night, after that it is rarely necessary.

We are then in no hurry to start early motion, and we can see no advantage or reason for it. We let the patient begin to feel like flexing his knee before we encourage him to do so. This is

PLATE 3.—Specimens removed in case shown in Plate 2, (1) Overgrowth of cartilage on femur; (2) loose body; (3) bucket handle cartilage.

usually about five to seven days. We start him walking about the eighth or ninth day. This does not mean he cannot start motion or walk much sooner. We used to urge the patient to walk within two to five days after operation, and though we rarely had any ill effects we believe that œdema, swelling and fluid in the joint are reduced to a minimum by keeping the patient quiet for a few more days in bed.

We advise physical therapy treatments and find it is usually from five to eight weeks before we have a symptom-free normal knee.

The same technic is carried out for external cartilages, the incision being made at corresponding points on the lateral side of the knee.

*Discussion.*—We wish to emphasize especially the following points:

1. In making the approach to the cartilage three definite layers about the knee must be identified and separately handled, namely, the skin, the capsule and the synovia. These structures should be approximated separately at the close of the operation.

## ARTHROTOMY OF KNEE FOR CARTILAGE INJURY

2. The direction of the incision is in line with the distribution of the sensory nerve fibers to the skin of the knee. Hence few fibers are divided and areas of numbness seldom result. With other incisions we used to have many post-operative complaints of numbness of an area of skin.

3. By leaving a fraction or rim of cartilage the synovia remains intact, there is no post-operative bleeding and there is no delay in healing. Leaving this rim is a point I have not seen mentioned in the literature.

4. The incision is placed so that if complete exposure of the knee-joint is found necessary an extension is in direct line with what is being more and more considered the proper approach to the knee-joint, as contrasted with the old method of splitting the patella, cutting straight across the capsule and tendons of the joint and other such incisions.

5. We can see no reason for insisting on early motion and walking during the first ten days of convalescence.

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